

THE SPIRITUAL INTERPRETATION
OF NATURE

MAN AND THE ATTAINMENT OF IMMORTALITY

BY

PROF JAMES Y SIMPSON
M A , D Sc , F R S E 7s 6d net

Second Edition, Revised

Prof J ARTHUR THOMSON writes "The biology of the argument is on sound lines A courageous endeavour which may turn out to be an achievement."

Prof JOHN ADAMS writes "Dr Simpson has deserved well of Religion in making this scientific presentation of her claims

Principal E GRIFFITH JONES writes "It is long since a volume has been published which makes so solid and original a contribution to this good cause as Professor Simpson's. He combines in himself some of the finest qualities and qualifications for his task, having the full and accurate mind of a scientist, the warmth of a devout believer, and the large outlook and grasp of a sound theologian, and the result of his study is a book that will rank high in the literature of the New Apologetic. This book may be commended as an intensely interesting and stimulating study of human origins and destiny, and whether we agree with the author's conclusions on the latter question or not, it is impossible to read it without abundant illumination on some of the vital moral and religious problems of life. It is a close knit and constructive treatment of an absorbing subject, full of quickening thought on every page. The exposition of the place and meaning of Jesus Christ both historically and cosmologically is a real contribution to religious thought

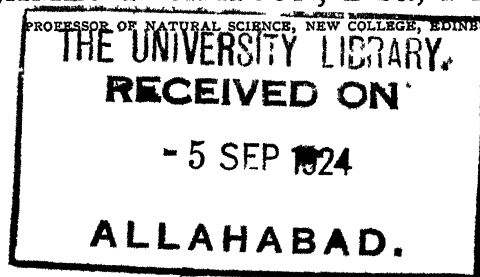
HODDER AND STOUGHTON LTD
PUBLISHERS LONDON

THE SPIRITUAL INTERPRETATION OF NATURE

BY

JAMES Y SIMPSON, D Sc., FRSE

PROFESSOR OF NATURAL SCIENCE, NEW COLLEGE, EDINBURGH



NEW EDITION, REVISED AND REWRITTEN

HODDER AND STOUGHTON
LIMITED LONDON

<i>First Edition</i>	1912
<i>Second Edition</i>	1913
<i>Third and Revised Edition</i>	1923

MADE AND PRINTED IN GREAT BRITAIN BY MORRISON AND GIBB LTD, EDINBURGH

TO
MY FATHER

"He is in the world, and the world is being made
by Him, and the world knows Him not"—JOHN 1 10
(from my father's Bible)

PREFACE TO THE THIRD EDITION

THE delayed issue of a third edition after the lapse of a decade has involved the rewriting to a very large extent of all the chapters dealing with matters that have formed the subject of scientific investigation in the interval, as also the entire revision and partial recasting of the sections devoted to more theoretical discussions. At the same time the general plan and scope of the book in its original form have been retained as far as possible, leaving it, as before, broadly introductory, yet also supplementary, to the writer's later work, *Man and the Attainment of Immortality*. Exigencies of space have prevented the consideration of several allied problems such as the significance of Beauty, and some more recent developments such as Relativity, which may find their place in a subsequent study of the Principles of Natural Theology. A glossary has been added to the present edition, as also two new illustrations (Figs 6 and 8) from Professor L. N. Woodruff's *Foundations of Biology*, for the permission to use which, indebtedness is herewith expressed both to him and to The Macmillan Company.

J. Y. SIMPSON.

September, 1923

PREFACE

THESE chapters, which have grown out of courses of lectures delivered both in this country and in America, are addressed to those who in their earlier outlook upon Nature felt sure of her inherent spirituality, but latterly have found difficulty in bringing this conception into line with some of the results of modern scientific thought. They contain, therefore, little for the specialist in science and philosophy, except perhaps in Chapters III and IV, whose conclusions may suffice for the general reader. For some schools of theology, they possibly contain nothing at all.

Where a writer's range of indebtedness is great, it is hardly possible to indicate it even by continuous foot-notes, although that has been attempted here in some degree. In addition to the stimuli of many writings—in particular the volume of *Papers read before the Synthetic Society*, kindly given to me by Mr Wilfrid Ward—I would acknowledge my gratitude to him from whose New Testament I have taken his reading of a familiar verse, while to Dr Sutherland Black I have owed much through many years. Nor can I refrain from stating what I have learned in conversation from my friend Professor John Clark of Boston University. Certain chapters and pages on topics relevant to their

xii SPIRITUAL INTERPRETATION OF NATURE

lines of special study have been read by my friends Dr Cargill Knott and Dr J H Ashworth, while Dr. John Kelman has added to a long list of kindnesses by reading the book in proof. Finally, I would express my indebtedness to Messrs T & T Clark for their courtesy in permitting my use of the article "Biblogy," contributed by me to their *Encyclopædia of Religion and Ethics*, as a basis for Chapters III and IV, as also to Mrs H M Bernard for permission to use the illustration on p 74 from her husband's book, *Some Neglected Factors in Evolution*

J Y SIMPSON

NEW COLLEGE, EDINBURGH

CONTENTS

INTRODUCTION	PAGE I
CHAPTER I	
KNOWLEDGE AND FAITH	10
CHAPTER II	
INFLUENCE OF SCIENCE UPON RELIGIOUS THOUGHT	31
CHAPTER III	
PRINCIPLES OF BIOLOGY	44
CHAPTER IV	
PRINCIPLES OF BIOLOGY (<i>continued</i>)	71
CHAPTER V	
EVOLUTION	103
CHAPTER VI	
NATURAL SELECTION	122
CHAPTER VII	
VARIATION	143
CHAPTER VIII	
HEREDITY	157

XIV SPIRITUAL INTERPRETATION OF NATURE

CHAPTER IX

SOME SOCIOLOGICAL ASPECTS OF HEREDITY	PAGE 182
---------------------------------------	-------------

CHAPTER X

ENVIRONMENT	200
-------------	-----

CHAPTER XI

THE DIRECTIVE FACTOR IN EVOLUTION	213
-----------------------------------	-----

CHAPTER XII

EVOLUTION AND CREATION	232
------------------------	-----

CHAPTER XIII

MENTAL EVOLUTION	251
------------------	-----

CHAPTER XIV

EVOLUTION AND MORALITY	271
------------------------	-----

CHAPTER XV

EVOLUTION AND EVIL	280
--------------------	-----

CHAPTER XVI

SCIENCE AND MIRACLE	295
---------------------	-----

CHAPTER XVII

EVOLUTION AND IMMORTALITY	311
---------------------------	-----

GLOSSARY	323
----------	-----

INDEX	327
-------	-----

LIST OF FIGURES

FIG		PAGE
1	GENERAL VIEW OF CELLS IN THE GROWING ROOT-TIP OF THE ONION	57
2	SEMI-DIAGRAMMATIC REPRESENTATION OF A CELL	59
3	CHROMIDIAL UNIT AND AGGREGATE	62
4	FERTILISED OVUM OF <i>ASCARIS</i>	86
5.	LATER STAGE IN FERTILISATION (<i>ASCARIS</i>)	86
6	DIAGRAM OF THE CHROMOSOME CYCLE OF AN ANIMAL	88
7	CLEAVAGE OF THE OVUM OF THE SEA-URCHIN <i>TOXO-</i> <i>PNEUSTES</i>	95
8	DIAGRAM OF ZONES OF CYTOPLASMIC DIFFERENTIATION AND THEIR DISTRIBUTION AT THE FIRST DIVISION OF THE EGG	98
9	DIAGRAM ILLUSTRATING WEISMANN'S THEORY OF INHERITANCE	168
10	DIAGRAM SHOWING ESSENTIAL PARTS OF AN APPARATUS OF EXCHANGE BETWEEN THE EXTERNAL WORLD AND CONSCIOUSNESS	256

INTRODUCTION

IN that intellectual conquest of the world which is the aim of every thinking man, no moment is more decisive than that in which he resolves with Matthew Arnold to see life steadily and see it whole¹ Like every human quest of the ideal it is unrealisable on this plane of existence, being an attribute of the Divine But the aspiration itself is significant and bears witness to that in man which is more than merely human

The moment is fateful in many ways In it is begotten a discontent that no closed system of science or philosophy or theology will ever satisfy The more complete the system, the more acute is the irritation Particularly in the comparative study of the reciprocal influence of the two great viewpoints of truth that are roughly characterised as religious and scientific is this unrest felt The average man has been educated in secondary schools where Nature-study is increasingly provided He passes through courses of scientific instruction, and sooner or later—if he thinks at all—he is compelled to contrast the fundamentals of this discipline with the fundamentals of a theology which is still largely mediæval His endeavour is to reach an interpretation of Nature, to attain an account of things that will be consistent, not merely with itself but with this other record, but he soon realises that there is much that is disparate in the two points of view, encounters pronouncements that are mutually destructive, and particularly in the regions where science and theology directly impinge does he find the incompatibility to be greatest

It is open to remark that such an intellectual rest-

¹ *To a Friend*

2 SPIRITUAL INTERPRETATION OF NATURE

lessness is quite gratuitous—how can there be relationship in any sense between the conceptions of science and theology? Thus from the side of science it has been said "So far as I have been able to ascertain, after many years in which these matters have engaged my attention, there is no relation, in the sense of a connection or influence, between Science and Religion. There is, it is true, often an antagonistic relation between exponents of science and exponents of religion when the latter illegitimately misrepresent or deny the conclusions of scientific research or try to prevent its being carried on, or, again, when the former presume, by magnifying the extremely limited conclusions of science, to deal in a destructive spirit with the very existence of those beliefs and hopes which are called 'religion.' Setting aside such excusable and purely personal collisions between rival claimants for authority and power, it appears to me that science proceeds on its path without any contact with religion, and that religion has not, in its essential qualities, anything to hope for, or to fear from, science"¹ Regarding the somewhat shallow characterisation of "those beliefs and hopes which are called 'religion,'" we only remark that many of them are held by men of strong and sound mind, who simply would not entertain them if they lacked connection with the general, or even with whatever special scientific, scheme of thought they have adopted. Their sense of the unity of knowledge, *i.e.* the unity of truth, compels them to consider the relations of scientific and theological thought. Knowledge or Experience is not divided into water-tight compartments where the activity in one compartment is absolutely isolated and uninfluenced by what goes on in any other. There is, to say the least, a tendency towards ultimate unity and rationality in all experience. Whether that unity is in the attaining human mind, or in some mind external to it, does not really matter at this stage. The indications of it are there, and they are only perceived by mind. These approximations towards unity suggest that there is a complete under-

¹ Sir E. Ray Lankester, *The Kingdom of Man*, p. 63

standing, a perfect knowledge, a final statement—in short, that truth is a whole, even as the universe, of which knowledge is the attempted comprehension, is a whole, and all the parts are interdependent.

On the other hand, there are those who maintain that in the scientific and philosophical contemplation of Nature there is nothing that is of assistance to theological thought. The experiences of the human soul in every age are for them the only important facts, they are the only valid witness to divinity. Here in the communion of the soul with God the religious man has that which alone is of real and lasting value, that, moreover, which science cannot take from him. The objective side of religion, so far as it is expressed in dogma, may be suffered to go its own way—it is not ultimately necessary, and it is something that is always vulnerable by scientific criticism. The rich spiritual experiences of the soul wherein it hopes, and fears, and loves, and learns, are the only witness, clear and unequivocal, to the Source of Being. Such a mind may even think it blasphemy to attempt to find out how God may be expected to act, from a consideration of His working in the past and present—it affirms only a rich incalculable liberty of action which the waiting soul may gladly experience, but will never even attempt to systematize. A life of faith, of rapture, of unexpected and unimaginable experiences—in these alone is found the transcendent witness to Divinity. So W. Herrmann, in Ritschlian endeavour to obtain a place for religion where she would be unassailable by the solvent touch of science, insisted: "The evangelical faith, because it ought to be an independent possession of the moral personality, must remain unentangled with the present-day development of free natural science."¹ But any isolation of these soul-states is purely fanciful. They may be proffered tokens of a transcendent Presence, but they are also linked with the ordinary life of the individual who experiences them, and so with the life of the world. They may even, as being given and experienced in consciousness, become legitimate objects

¹ *Die Religion*, Preface, p. iv

4 SPIRITUAL INTERPRETATION OF NATURE

of scientific examination and account, incomplete and partial as that account may be. If on one side in touch with the unseen and eternal, they yet are set within the visible and temporal.

And further, this extreme position, when regarded from the standpoint not merely of the unity of human knowledge but of the unity of Nature, is seen to be little less than intellectual suicide. For if this world in which we find ourselves is God's world, then must it bear witness to divine origin and control, and the one thing that can no longer be permitted is the isolation of any special object in the universe, *e g*, man, or any faculty of that object, and the predication about it of relations and correspondences that are construed to imply an essential incompatibility between that object and the whole of which it is a part. If God is, then that which He has made must bear witness to Him, it must be in some sort of intelligible relation to Him.¹ Science and Religion afford two partial accounts of that ultimate Unity in which every man lives and moves and has his being. For even if it were granted that the one moved more in the realm of Intellect and the other in that of Feeling, yet it is in consciousness that man is aware of them both and exercises himself in relation to them. Through them he comes into correspondence with, and forms his idea of, the Divine Nature.

Natural Science and Theology are thus two living bodies of thought which in virtue of their very life—life that implies assimilation of all assimilable elements in its environment—grow and expand and change from age to age in outward form and inward content, and shall continue so to do until that day when their relationship as complementary expressions of fundamental truth will be universally appreciated. And while this implies that in general all features that are obviously contradictory must be excluded, there is at the same time no call to insist upon absolute corre-

¹ Acts xvii 26-28, Rom i 20. St Paul, in the latter passage, seems to indicate his impression that primitive peoples reached their belief in God not through intuition, but through some mode of reasoning akin to the argument from design.

spondence of detail between schemes of scientific and of theological construction, still less to attempt any so-called reconciliation between Science and Scripture. If, then, there is this fundamental linkage of thought, this reciprocal influence of allied studies, it is beside the mark to urge that the day in which Theology had anything to hope or fear from Science is past. In an age whose practical interest is sociology and which tends to express its religion in terms of psychology, it may not be immediately obvious that the relations of scientific and religious thought are becoming an increasingly important question. Yet the philosophy of Nature, in whatever terms expressed, cannot but touch her sublimest product, it is man's way of thinking about her, of studying his relation to her. It may be formulated in many ways—there are many systems. We want to reach that one which shall most truly include all the facts and most worthily express man's possibilities. To-day we cannot but be aware of views specially characteristic of the age, that are moulding the minds and even the hearts of men. The workers whose dealings are with Nature feel very certain of her, and some amongst them build up their whole view of things, starting from what they believe they know, while the doctrines that have been collected under the name of theology they tend to set on one side as being largely in the clouds and apparently without any definite connection with the mass of knowledge ordinarily acquired. And so there has come about a gradual alienation of certain strong and scientific minds, who, while they maintain that there is a natural history of the spirit, tend to forget that there may also be a spiritual history of Nature. Accordingly, when it is suggested that the theologian should strive to appreciate for himself the religious implications of science, it is not because men are saved by science—although there is more than one very true sense in which the statement is indisputable—but rather because of the sympathetic value to himself in putting his mind in touch with the trend of the most distinctive thought of the day, and so furnishing himself with additional

6 SPIRITUAL INTERPRETATION OF NATURE

means of bridging the gulf between his intellectual hemisphere and that of his usually more accurate, if sometimes more prosaic, scientific neighbour

But those whose business is the commerce of the mind are few compared with the vast companies who buy and sell or live by the sweat of their brow. And yet it is only a question of time till many of the deliberations of the scientific society become the debated questions of the factory yard and market-place. Hence arise the perpetual difficulties of popular thought—difficulties that are more likely to increase rather than lessen, owing to the incredibly rapid march of science compared with the leisurely gait of theology. A certain parallel, indeed, may be found to subsist between the advance of an army and the intellectual and spiritual progress of a Church. In front are the prospecting scouts whose duty it is to ascertain the path by which the main body may proceed with greatest safety. It is their business to be on the outlook for every indication of fresh light, to know the times and seasons, to test the value of any movement in a specific direction, to detect all sources of possible danger. To them must be given perfect liberty of investigation—they know that they carry their lives in their hands. Behind them marches the main body, at a very ordinary pace, moving along with definite halting-points, while in the rear come the laggards, those who have failed to keep up with the main body, for reasons which may be in no way discreditable to them. It would thus appear to be impossible to bring every one forward at the same time. As a result, country that is familiar to the scouts is just looming on the horizon of the main body, while it is a *terra incognita* to the rear. Truth which is now old to some of us is only arriving elsewhere. This is the case not merely with the different mental groupings of our own people, it holds good of the wide world.¹ Those questions concerning the relationship of scientific and religious thought will always be with us in some form or another. At one time the clouds may be lying thick upon the army in the plain below, while the scouts are

¹ Cf. P. N. Waggett, *Religion and Science*, p. 20

above it high up on the mountain slopes. At other times it may be those who have pressed onward and upward to look ahead who have found themselves temporarily caught in the mist, while it is clear in the valley below. Nevertheless, the mists are ever there in some degree at one point or another—a necessary element of our earthly existence—and shall be until that morning breaks when they roll away for ever, and “we shall know even as also we are known.”

Further, men can no longer remain insensible to those great scientific truths that have a direct bearing upon conduct. The moral significance of the essential unity of life, the place and implication of life and death in Nature, and the principles of heredity, are instances from the organic realm that offer food for reflection which will assuredly be a necessary part of the fare of our successors, the inorganic realm is likewise by no means devoid of similar spiritual aliment. And it is not merely on the constructive side that this generation finds itself face to face with a new work, but there is much call for careful combat of half-truths which are often in their results more diabolical than a genuine misstatement. Thus it is not difficult to twist the doctrine of the survival of the fittest into confirmation of the most disastrous conclusion that whatever is, is right. This must be met by showing that the surviving fitness need not necessarily have any moral content, and is never synonymous with perfection. Again it is possible to lay such emphasis on certain aspects of scientific truth that the individual shall feel that he is of no account. This must be balanced by the more significant truth that every human being is a trustee of those hard-earned gains of the æonian generations of life that have accumulated to form the natural and spiritual estate of man, and as such has an account to render.

It is therefore positively in the interests of the soul bent on the adventure of faith to realise the essential kinship of all knowledge, but more particularly the identity of mental attitude that is required of him who would understand the courses of the stars and the ways of God with man. It is no longer possible to maintain

8 SPIRITUAL INTERPRETATION OF NATURE

a radical distinction between mental or natural science and theology either in the nature of the facts with which they deal, or in the human powers that are brought to bear upon these facts, or yet in the methods of reasoning that may be applied to the facts. For theology, when she treats of the Being of God, can but draw her data from the facts of the natural and spiritual worlds as they are written in Scripture, in the pages of philosophy and science, and in the experience of the individual. To some these proofs may be insufficient and unsatisfactory, but there are no others. The world as the great antecedent fact of divine creation may surely be held to contain within itself the interpretation not merely of its parts but of its relation to that which constitutes its Ground¹. And it is a most striking fact in this connection about the teaching of Jesus that He continually saw and pointed out the reflection of His spiritual instruction in physical events. The natural and the spiritual were united in all His parables as they are united in reality—two aspects of the same thing, yet hardly simultaneous in their impact, for that which is first is natural, afterward that which is spiritual. It is only the heart that is in total ignorance of what religion is that either in fear or scornful joy can imagine that any such inquiry can result in damage to religion. The sense of dependent relationship that is involved in religion cannot be touched by any study of the intellectual account of religious experience usually termed theology. The personal attachment to Jesus Christ that is at the heart of any genuine Christian endeavour, whether individual or social, is unaffected by theories of His life and work. It furnishes its own justification, and by this the association of miracle or of "wonder" with Him is judged, not *vice versa*. To this distance the following studies hardly extend. They are simply concerned with the basal elements in all experience, and the relation of the particular intellectual accounts that have been popularly labelled "religious" and "scientific". In face of the rapid formation of a definite religious public opinion outside the churches, in

¹ Cf J. Bascom, *Evolution and Religion*, p. 35

face of cleavages of opinion within the church, in face of the fast developing recognition of the essentially spiritual character of much of modern science, and the essentially unscientific character of much traditional theology, it is necessary that our age look at these questions afresh for itself. In the interpretation of Nature man has always felt himself close to the highest he has known. The hearts of the Nature-worshippers of long-past days responded to a real witness of divinity, and we may be very sure that a religion that resolutely refuses to regard this element will make but a limited appeal, and that the book of reconstructed Christian theology will contain chapters whose inspiration will be found in the purified and reverent contemplation of Nature.

CHAPTER I

KNOWLEDGE AND FAITH

At the threshold of all inquiry lies necessarily the question of the nature and character of Knowledge, but particularly in estimating aright the reciprocal influence of Science and Religion, so often contrasted as Knowledge and Faith, is such initial investigation in part demanded. Now the results of experience—the ultimate unity and rationality of which we have already postulated—however they may be acquired, whether won at first hand or received upon the authority of others, are collectively regarded by the individual mind as knowledge. Yet there is knowledge and knowledge. The man in the street has knowledge of a certain kind, he knows that the sky is blue, that the grass is green, and many other facts whose practical value is probably greater to him. But pass into the laboratory, and the physicist will show us that the luminosity is due to the partial reflection of light from the upper regions of the atmosphere, because of the minuteness of the particles of air, the rays of quicker vibration are sent back in greater quantity, thus producing a general tint of blue. The botanist will likewise tell us that the verdure of the grass is accounted for by the existence of minute intracellular living units called chloroplasts containing a complex green substance known as chlorophyll, whose function is to catch more particularly the red rays of light in order to employ their energy in the difficult chemical operation of decomposing carbon dioxide and water in connection with the process of assimilation. As a matter of habit and custom we have come to think of the latter type of knowledge as scientific, and of the former as unscientific.

Now there is no reason to doubt the facts of the street-man's knowledge, we no more question the genuineness, the reality of the odd fact that he picks up in one thoroughfare than that of the old button which he picks up in the next. And yet his knowledge differs from that of the man of science. In what respect? It is in general a knowledge of isolated unconnected facts, the knowledge of the trained scientific mind, on the other hand, is a knowledge of facts and their relationships. The two vary as the heterogeneous contents of a schoolboy's pocket differ from the ticketed objects in the glass-covered cases of a geological museum. The bit of string, the pocket-knife with one blade broken, the dead mouse, the half-chewed apple, the glass eye gouged out of his sister's doll—there is no bond of connection between them. On the other hand, the ordered series of fossils in the museum, arranged to exhibit their relations and interrelations, systematically express the results of years of laborious investigation.

The foundation of all scientific knowledge is facts—facts physical or mental, facts culled by external observation or internal observation—everything, in short, that has the power of being revealed to consciousness. Facts are the premises of knowledge, according to their importance they are the bedrock upon which, or the bricks out of which, the superstructure—the Temple of Knowledge—is built. As such, previous to their employment, they must be critically inspected, and if, as the result of this inspection, their nature and limits cannot be determined, if they cannot be separated from all other facts so as to stand out clear and defined, the man of science will refuse to use them. Further, the man of science will not make use of facts that are incapable of verification or test. A series of individual experiences that are out of all relation to anything that he or his fellows have known, and which he cannot therefore classify or collate, will receive no place in the construction of his science. He may, so to speak, keep such experiences and facts in storage, so as to be available for comparison when others like to them are

chronicled, but, in general, a set of experiences that are insusceptible of repetition by another would constitute no part of a science. On the other hand, such uniqueness would not necessarily in itself involve them in discredit.

Finally, these ascertained, verified, classified facts must be wrought into a system. Nothing less than this can transform unscientific knowledge into scientific knowledge. Scientific knowledge is systematised knowledge in which the personal equation has been eliminated. The slow accumulation of data, the year-long studies of the specialist, the reiterated experiments of the patient researcher are all conducted in the hope that they will eventually lead to the discovery of law. To the true man of science this ultimate ideal, this impulse towards unity and consistency, means just as much as the rigorous verification of his facts. The difference accordingly between knowledge scientific and unscientific is not so much a question of reality as of method. The man in the street picks up his facts, like everything else, just as he finds them, and takes them to be what they at first appear to be. The man of science subjects his facts to critical examination and logically works them into a system. Science may therefore be defined as ordered, tested, organised knowledge.

Further, it is no just conception of science which claims that it shall be free from error or complete in itself. A scientific investigation, at least in its initial stages, is like groping in the dark, and the scientific inquirer claims the right to feel about in every direction, even if this involves seeming retrogression, and to describe at any moment what he finds, nor be challenged, as if for some moral delinquency, should both his direction and results turn out later to be wrong for his errors of fact and of assumption sometimes prove to be his best incentives to success, and the way round is often the straightest road in the end. Thus, Oersted's discovery of electro-magnetism in 1820 was the result of his falsely conceived theory as to the effect of a heated wire upon a magnet, and the youngest mathematical student adds and multiplies infinities, and works

with minus quantities, their imaginary square roots and other useful arithmetical impossibilities¹ Were perfection an essential attribute of science then should we have no science, nor, indeed, for that matter, anything at all Suppose that the man of science had all the facts at his command—which he never has—suppose, in addition, that they were divinely imparted, yet would there be no infallible way of recording them, nor guarantee that they had been correctly interpreted² St Paul's saying covers the whole realm of experience—"Now we see through a glass darkly"³ Absolute knowledge science has never professed nor knowledge of "things in themselves"—that is left to the philosophers Her knowledge is a knowledge of relations—relations, *e g* of co-existence, succession, likeness and difference between things The greater the number of such relations, the more detailed and the more general such knowledge—in this consists the growth of science The unrelated thing, the unrelated fact, is useless it is useful only in virtue of its relation to other things The interpretation of the world is simply the finding and understanding of all the relations that obtain amongst its actual partial expressions The increase of knowledge is not so much due to any new sense-perception or any particular verification from experience, as to a new consistency with an already complex system, which in turn was itself built up out of many preceding alterations of inference from perception It is important to realise that the facts of science are for the most part "relations" the laws of science are statements of relations found to hold ordinarily under definite conditions This necessarily gives to Science an abstract character, and inasmuch as these relations are infinite,

¹ $\sqrt{-x}$ is an arithmetical impossibility because there is no quantity which, multiplied by itself, will give a minus product On the other hand, it has a relation with reality, because it can be used as if it were a real quantity, and "all the laws and relations relating to real quantities can be applied to it" (St G Mivart, *The Groundwork of Science*, p 92) The mathematician, that is, formulates, previous to the employment of such symbols, a system in which they shall play a part, and attaches a specific value to them

² Cf R S Hollman *The Sphere of Science*, p 13

³ 1 Cor xiii 12

14 SPIRITUAL INTERPRETATION OF NATURE

Science partakes of the character of an endless induction. The same considerations hold also with regard to mental facts, those most certain, if also most variable of all facts. Their inclusion is demanded, for it is useless to attempt to limit Science to objective data only. Pure objectivism may be permissible as a scientific ideal, but it is unrealisable in practice, for however carefully we may be on the watch, subjectivism creeps into our data. In certain branches of science the subjective element is most important and demands recognition in any full account of the phenomenon in question, and, in any case, subject and object are united in reality when it comes to intellectual contemplation of the object.

Again, our information with regard to the external world is supplied to us by our senses, whose instruments are of very limited capacity. When we consider the range and power of these senses, we become intensely aware of the limitations of human scientific endeavour. Sometimes the fact of this limitation is unwisely emphasised in prejudice of scientific knowledge, as (falsely) opposed to religious knowledge. These limitations of science are, however, the limitations of humanity: they are indeed the limitations of natural science, but in the same degree of psychology, or of theology. Science is not alone in suffering from the inherent imperfections of human power.

Scientific knowledge, then, is human knowledge acquired by what are usually termed the five external senses—in some instances reduced to two¹—within the span of threescore years and ten. Further, it is a commonplace of comparative physiology that many creatures from insects to mammals excel us in certain degrees of power of sense-observation. No human eye has the condor's farness of vision; in man the sense of smell is almost undeveloped compared with that of a bloodhound, whose whole recollection of "a perfect day" is in terms of smells. Lord Avebury showed that ants respond to the ultra-violet rays of the spectrum.

¹ e.g. Helen Keller, the blind deaf-mute *The Story of My Life*, 1903

which escape our direct vision that is to say, they possibly see more colours than we do, and different ones. Indeed, some naturalists concede a sixth sense to insects, while others believe that reptiles have a sense of water, and fish a pressure sense, since either deficient or excessive pressure is dangerous to them ¹. Most of our observations of Nature are made through the eye, yet all objects that vibrate less than four hundred billion times per second, or more than seven hundred and fifty billion times a second, are absolutely invisible to us. The visible spectrum occupies only $\frac{1}{100}$ th of the known range of ethereal vibrations. Further, we can see pulsations of intermittent flashes at the rate of six in a second; beyond that number they give us the sensation of a continuous light. It is notorious how the reports of the eye differ with its distance from the object regarded; its powers of accommodation are slight. We alter its relation to the objects that we seek to study by microscope and telescope. In no case does it furnish us with an absolutely exact account. The information is merely relative, and the correction is made by that which uses the imperfect instrument, our Reason. One might even say that the faculty of sight in man is not imperfect, it is only the instrument that fails.

Again, although, on the whole, the ear is more discriminating than the eye, we can only hear sounds within a definite range of vibration to the second, beginning at about thirty-three and ceasing over thirty thousand. Beats up to fifteen in the second can be distinctly heard, beyond that they blend into a continuous sound. We hear roughly over a range of eleven octaves, and yet not every one can pick out the shrill squeaking of the bat. Physicists assure us that there must be thousands of octaves beyond the eleven. Even the loss of definite mobility in the external ear hampers man in his determination of direction. Finally, with regard to touch, unique amongst the senses in that it can take the place of some of its allies, as, *e.g.*, sight and

¹ This is not merely a modification of a sense of touch for beneath, and associated with, the lateral line is a longitudinal canal provided with peculiar bodies which have all the appearance of sense organs.

hearing in the case of Helen Keller, and supreme in its assistance to man the creator, as all handicrafts testify, we are aware how easily it may be deceived, particularly if tested without the assistance of sight

Indeed, in the ultimate analysis, all our sense impressions are found to be but perceptions of molecular motion. Touch, hearing, and sight are instruments by means of which the living body becomes aware of different rates of motion. How fundamentally akin in operation these different instruments are, may be gathered from the following illustration. "In a darkened room, where a steel disc quivers ten to twenty times a second, the finger is sensible of a vibration, if it moves sixty-four to thirty-two thousand times, the ear hears a note more and more high-pitched, if it vibrates still faster, the finger feels warmth and next heat, after four hundred and fifty billion vibrations per second, the eye beholds a reddish glimmer, growing lighter with every acceleration of the motion of the molecules, and terminating in a white incandescence comprehensive of all colours whatsoever. We may accordingly say that the ear sees the sound and the eye hears the light, and it is a conceivable possibility that in other beings than ourselves a single organ might be able to perceive the foregoing molecular motions successively as a mere intensification of the same sensation, or as a kind of modulation of shades of a *single* colour" ¹ The illustration seems to involve change in the character of the media of vibration as the passage is made from sound to sight, yet air is ultimately explicable in terms of ethereal motion. The real discrepancy is between the ethereal vibrations and the sensations produced in the brain. It further implies change in the character of the vibrations as these pass from vibrations of the mass to motions of its constituent molecules. Yet it may be taken to show very clearly the division of labour that has been achieved amongst the senses. Each of them covers a certain limited stretch on the vibration scale, but between them all, it is only a very small portion of that range that is so covered.

¹ Prof F. Bettex, *Modern Science and Christianity*, p. 74

Consider then that on our planet there are numberless objects with which it is impossible for us to come into relation simply because of our physical constitution, and that of those objects of which we are aware it is only with some few aspects that we can become acquainted. This conception of a world beyond our senses at once supplies us with an arena of momentous possibilities. We lack entirely a sense for electricity, being unable to distinguish between positive and negative electricity, were we so endowed, a new world would dawn on us and Science. Think of the world without the sense of smell—how completely we should have been lacking in suspicion of the variety of flavours and perfumes. Of these sense-limitations man is keenly aware. Other animals are similarly endowed, some better and some worse, yet there is no sense-discontent within their lives. Man alone is aware of a failure of correspondence between his faculties and the bodily instruments with which they are equipped. These defects he seeks to remedy and thus enlarge the exercise-yard of the spirit within. nevertheless it is still confined within the prison of the human frame. Small wonder that it should reconstruct for itself in imagination some other sphere of existence where, with instrument worthy of faculty, things would be seen and heard and known as they really are, without the distortions involved in space and time. St Paul speaks of what "eye hath not seen, nor ear heard, nor hath entered into the heart of man to conceive,"¹ as prepared for them that love God. But this involves a corresponding preparation in those who would receive the revelation, and we may dimly perceive how great must be the change before an individual attains that perfect comprehension of Ultimate Reality and correspondence with it, in which the conditions and joys of a future state must so largely consist.

It would therefore seem as if that particular sense construction of the world that is ours is relative to the capabilities of our senses.² We may suppose that to beings with acuter senses reality would appear other-

¹ 1 Cor. 11. 9.

² Cf. J. H. Newman's *Oxford University Sermons*, p. 347.

wise, would be more completely known even the so-called properties of matter might wear another guise. An additional sense might give us a very curiously expanded conception of the world. That particular conception which we have attained is suited to our abilities to comprehend—in fact, it is the direct result of them. Further, that conception has evolved throughout the ages. There is a continuous unfolding of reality to the human mind, and it becomes increasingly realised as spiritual even on the physical side. Such a view involves no Kantian dichotomy of reality, the real and the ideal are but different aspects of one and the same thing. From the divine viewpoint our helpless contrasts of spirit and matter, of natural and supernatural, must be strangely non-existent. They may testify to the incompleteness of our conceptions, possibly they are relative merely to this particular stage of development. Certainly they can never establish these conceptions as mere delusions.

Subject to such limitations, science cannot and does not deal with absolute certainties. At best she replaces the more uncertain by the less uncertain. Such has been her mission throughout the ages. She is always provisional, she can never be final. Indeed, Boutroux went so far as to call science "the hypothesis of constant relations between phenomena"¹. The sphere of certainty can only embrace those ultimate self-evidencing intuitive intellectual perceptions and allied principles of reasoning without whose assistance the quest for knowledge or the demonstration of irrationality in things is alike vain. All else, all other data and all generalisations from such data, lie within the sphere of the probable. Nothing is easier than to show that all the generalisations of physical science are probable only.² The same is true, though not so obviously, of her facts. And yet every statement that the man of science makes concerning some object that is external to him is an induction, and as such can only be probable,

¹ E. Boutroux, *Science and Religion in Contemporary Philosophy*, p. 244.

² Cf. W. S. Jevons, *The Principles of Science*, chap. x.

except on the basis of his mind being infinite and his judgment infallible, and so capable of perfect knowledge. An astronomer observes a star through his telescope. He is certain that he experiences a sensation of sight. He is likewise certain that he, experiencing that sensation, exists, and that there is a cause for the sensation. From all the data that he can gather he infers that the star is the cause of the sensation, but strictly he can never know with absolute certainty that his solution is correct. Aided in every possible way, his knowledge would still remain probable, highly probable if you will, for the degree of confidence will naturally vary with the degree of probability, but not strictly certain. Even in the exceptionally clear science of mathematics the old-time claim of absolute truth for its propositions is gradually giving way to an unassailable but infinitely more modest claim of consistency. No mathematician in the world knows whether the sum of the angles of a triangle is equal to two right angles or not. The statement is true in the case of the Euclidean system of postulates and deductions. But that is not the only system, and others just as consistent are conceivable in which the sum of the angles is greater or less than the Euclidean figure. Absolutely certain knowledge is no product of inference. In origin it is direct, intuitive. The data of natural science lack these characters, they are always derived, indirect, inferential.

It hardly needs to be added that the probability of things lies not in Nature but in our minds. The degree of probability is an index of the degree of knowledge. Nature, we assume—otherwise all motive for scientific study would be gone—is a rational process. Whatever happens takes place in accordance with principle and order. There is nothing capricious in Nature, nothing uncertain about her activities in themselves, but there is a marked shortcoming in our understanding of these activities. That understanding takes the form of those statements of relations between facts, commonly known as “laws of Nature.” But a law to be complete would need to cover every relation and every fact. Yet every

relation we do not and cannot know, still less every fact. Accordingly such statements of relations are probable only. The uniform denial of the probability of knowledge could only follow a claim to omniscience and therefore to infallibility. Knowledge is a considered *résumé* of higher-grade probability.

To speak about our knowledge of physical science, then, is really to state our mental condition with regard to it, and this, like every human activity, ultimately rests on the theory of probability. As a matter of fact, our lives in every aspect are one long conscious and unconscious peradventure. We eat food on the probability that it will nourish us, we take the street car on the probability that it will convey us to our destination, we call in a physician on the probability that he can aid us, and we arrange for to-morrow's work, because with some things if not with some one we have learned to associate continuity.

It will follow, then, in every department of learning, that it is never necessary—since, in fact, it is never possible—to do more for any proposition than to show that the balance of probabilities is in its favour¹. The final claim of any fact, of any doctrine, to recognition is its reasonableness, and this we establish by carefully weighing the statements made about it, and accepting or neglecting them according as the balance of probabilities is for or against them. When we have done so, we are perfectly justified in adopting that proposition as a doctrine of science or a rule of conduct. It is only in proportion as we thoroughly “test all things” that we develop the instinct to appreciate and the power to “hold fast that which is good”. And if at times we are apt to be oppressed with the feeling of uncertainty in the round of human existence, we shall be helped in holding on our way more steadily when we clearly grasp the fact that in this universe in which we find ourselves, “only he who is willing to walk by faith can walk at all”².

It is important, however, to note that in addition

¹ Cf F S Hoffman, *op cit* p 30

² W N Rice, *Christian Faith in an Age of Science*, p 100

to these natural limitations, science often imposes upon herself artificial limitations, and there is a sense in which scientific knowledge has value only in proportion to these self-imposed limitations. To honour science is to respect her self-imposed limitations. To decry her "narrow outlook" is to fail in appreciation of her value. For she can only make progress in so far as she definitely confines herself within certain clearly marked limits, and rigorously excludes everything else. The chemistry of sugar has in itself no direct relation to diabetes or other problems of animal or vegetable pathology and physiology, it simply analyses the substance sugar and considers the relations and proportions of its elemental constituents. The value of a science is in proportion to the degree in which it strictly limits itself to the special set of characters it proposes to investigate. And the same holds true of Science in general. Much of the confusion that has from time to time arisen in consideration of the relations of scientific and religious thought is due to the fact that, after having made certain limitations in order to reach certain conclusions scientifically, men have proceeded to apply these conclusions far beyond the limits that were imposed in order to reach them.

But the chief danger in all scientific procedure lies in the possibility that, after having studied a series of phenomena under his self-imposed limitations, the man of science is sometimes tempted to imagine that his account thus acquired is the whole story, and so remain oblivious to other significances and interpretations which are, at any rate, just as valid, and which must enter into any complete account of a phenomenon. Of the autumn colouring of leaves, the botanist will give a wonderful account in chemical and physical terms—a series of changes induced initially by a difference in temperature and the gradual breakdown of certain cellular constituents of the leaves. But are we therefore entirely to disregard the æsthetic appeal? Not so, if the objectivity of any phenomenon includes its social relations as well. Darwin explained in a remarkable way the coloration of plants and animals on the principle of utility; but of what advantage to the tree are these

flaming reds and gaudy yellows? "Nature," says Mozley in his *University Sermon* with that title,¹ "in the very act of labouring as a machine," in virtue of the same laws, "sleeps as a picture", and the one aspect is as true as the other. The internal changes in the variegated foliage of autumn have significance both for the tree and for the man of science in his endeavours to express their story in terms of physics and of chemistry, but correlated with these are external changes which make appeal to another aspect of man's being and which must be included in any complete account of the forest. In considerations such as these we become aware of the incompleteness of a purely mechanical interpretation, so far as it professes to deal with the total significance of phenomena.

It is perhaps to-day, more than at any other time, peculiarly important to have a clear conception of what it just is that science can do, and what exactly is the worth of scientific knowledge. The appeal of science is to experience, which at once limits her accounts in a very real way. Of origins she can give no experiential account—it is questionable if the category of ends comes naturally within her sweep as pure description, and to final ends she can bear no witness. The highest ideals for which men strive are not those that we win from science, although in matters like eugenics she may give substance to them, science may give us an ideal of accuracy, but not yet of duty. The strictly scientific fact—*i.e.* one which can be expressed in terms of measurement, or in some physical aspect only—is but a part of reality. There are facts and facts, and justice or goodness or the consciousness of them are facts of which an account must enter into our description of reality, and they are more likely to influence the scientific fact than *vice versa*. The strictly scientific aspect is objective—that which can be reduced to figures and which has a relative stateableness. It is an aspect, further, the account of which, studied and accurate though it be, covers no more than a hundred years of a process that has synchronised with time itself, it has broken in, so

to speak, at a certain stage, late in the day As if some pageant had been in progress since the dawn of creation, and the descriptive reporter had arrived late on the scene He may guess what has preceded by certain features in what remains, he may surmise that there is a *dénouement*, but strictly, *quâ* man of science, he does not know

Again, this process is so involved and intricate that we can be perfectly certain that at no single moment of it do we get an accurate and full description It is proposed to find out how any particular portion of the pageant is mechanised, but there are so many factors involved that the problem in itself seems insoluble Accordingly, it is stripped as far as possible of certain features, it is reduced and simplified, and then a statement is offered But this statement represents only an aspect—indeed only an aspect of an aspect, never is there any direct touch with reality Indeed, the farther science proceeds in her ideal, abstract representation of phenomena, the farther she gets from reality, which is infinitely more complicated than the network of laws that comprise that representation The relations of any single fact are infinite, and science is closest to reality when treating of the relations of that single fact At the same time in proportion as she attempts to form a picture of the infinite relations of infinite facts, her grip upon any particular bit of reality tends to be less effective At the best she offers, in a now familiar simile,¹ a linear succession of juxtaposed cinematographic pictures which, as so many external snapshots, fail in their expression of that which from the inside takes the form of a continuous developmental process As Professor L T More puts it, if extremely, "Science, in other words, like philosophy, has no ontological value"²

Such conclusions are likewise not wholly unconnected with those limitations of the senses to which reference has already been made What we perceive, to take but one example, are not realities We never see things as they are, but as they were All sight depends on the

¹ H Bergson, *Creative Evolution*, p 322

² *The Hibbert Journal*, vol vii p 881

24 SPIRITUAL INTERPRETATION OF NATURE

definite rate at which light travels. With very near objects, the difference is very minute, but still calculable. The moon is 240,000 miles away—we cannot therefore see her as she is, but as she was one and a quarter seconds before. Some of the fixed stars we perceive by light rays that left them about the time of the birth of Christ. Again, the study of physical science—and increasingly of biological science—is statistical. It deals with averages. Therefore the scientific account of any phenomenon is in the last extreme but a skiagraph, a more or less correct but shadowy outline of some portion or manifestation of that Ultimate Reality, which we can never hope to fathom completely. Reality may be something that obeys the scientist's abstract network of law at a certain point and to a certain extent, and yet is something greater than law, greater than all his explanations of it. But to have learned this is to realise that there is a point at which his methods break down, that it is just possible that truth may have been revealed in more ways than one, that the achievement of knowledge implies moral as well as intellectual qualities, that after all it is not to the clear-sighted nor to those of a far vision that it is given to behold Ultimate Reality—to see God—but to the pure in heart. Whence arises that spirit of humility without which it is impossible that any man, learned or unlearned, may enter that Kingdom of Truth which has as capital the City of God.

Such being the case, the hoary antithesis between Science, *i.e.* Knowledge, and Faith proves not to be so derogatory to the latter as it was once supposed to be, and with the recognition of this fact disappears much of the occasion of these old-time conflicts between Science (representing, as was supposed, unalloyed certainty) and the Faith (as representing a distinctive form of doctrine with a more or less nebulous basis of fact). In any case, the so-called warfare between Science and Religion was never a clash of facts, although it often was a tourney between definitions. But what we may have—what, in fact, we do have—is a scheme of, *e.g.*, chemical knowledge, and a scheme of religious

knowledge, in both of which faith plays an important and vitalising part. Chemical knowledge and religious knowledge are alike based upon facts of experience, but in the shaping of that experience faith equally plays a part in either case. To the religious mind faith is usually "the substance of things hoped for", to the scientific mind much more immediately it is in large measure "the substance of actual existing things". For all scientific knowledge is based on such stupendous, yet perfectly natural, assumptions as the uniformity of Nature, the universal validity of the Law of Causation, and, we might even add, the objective existence of the external world as distinct from our sensory perception of it—assumptions which Huxley himself admitted¹ could not be proved by the experience we had of them, nor indeed by any amount of experience. How then did he ever dare to accept them? "It is quite true," he said, "that the ground of every one of our actions, and the validity of all our reasonings, rest upon the great act of faith which leads us to take the experience of the past as a safe guide in our dealings with the present and the future."² Science, in short, is a linkage of data dependent on faith in this uniformity hypothesis.

So characteristic an attitude, so basal and omnipresent an intellectual activity as that of faith challenges inquiry as to its origin. Possibly it is simply a reflex of a feature of the race, namely, that spirit of trusting adventure, often with little to justify it, that has been the mainspring of all progress, mental and material.³ It was a Lamarckian principle that new needs induced the development and functioning of new organs—it is a question whether the generalisation should not be more sweeping, and a new need not be merely the cause of every modification, but of every aspiration. Had there been no mutual reaction in the sensitive epidermis when first in the presence of light rays—no incipient "will" to see, no "faith" to follow the gleam—the eye had never been developed. Had

¹ *Evolution and Ethics, and other Essays*, p. 121

² *Science and Christian Tradition*, p. 243

³ Cf. Prof. J. Ward, *The Realm of Ends*, p. 415

there been no mutual reaction in the sensitivity of the human mind first aware of the influence of a spiritual world, there had been no discovery of God. Faith is the giving substance to things hoped for: it drives us into action. It represents an effort, an outpush in a certain direction because of a felt want. This self-committing venturesomeness, this launching of our minds in a specific direction, is the most fundamental act in all human nature. Without it there could be no experience, no acquirement of knowledge, unless as by a recording cognitive automaton, dwelling in passive sense-perception alone. Faith is the great necessary *primum* of all endeavour, the yeast in the raw material of knowledge. It can be transmuted into knowledge through experience, and this in turn stimulates faith. Thus there is no such thing as pure knowledge, it is always an alloy. And faith can never die, because of that subsequent progressive verification that is its inalienable accompaniment, particularly in the deepest things of life.

Faith, thus exercised scientifically, assuredly gives us a conception of reality that is as inadequate as the conception of God that results from the religious exercise of faith. Yet we can see the great progress in both views even within the span of the Christian era. The contention is that the faculty exercised is essentially the same, and that ultimately it is exercised upon the same object, although upon different aspects of that object, and in different degrees. The faith that is involved in all knowledge is man's nature going out towards that in the universe which secures his place in it. The faith of science and the faith of religion are alike justified as the basis of the conveyance of the knowledge of Reality. The greater uniformity in the results of scientific faith compared with those of religious faith is in no way prejudicial to the latter. Even in the case of the former, where the determinations are most subtle, whether in that exercise of the senses or the elaboration of the results achieved, the uniformity is by no means so general, and agreement does not necessarily mean that the judgment reached is true, or rather

that it is not largely relative. In a greater degree more subtle, refined, and sensitive is that exercise of the faculty of faith in the winning of the secret things of God. And while a consensus can only establish that to which there is general consent (and even this only problematically), it can never suffice to disprove any particular achievement. Of any thirteen people in a cave probably not more than one will hear the shrill squeaking of the bats which all can see or feel fluttering around. The consensus of the majority that no sound is audible does not invalidate the testimony of the one who says he hears a sound. The majority are alive to many aspects of the bats, but there is one individual who can give a more complete account than all the others.

Yet man is not completely man merely when he knows, or consciously exercises that will to know so intimately associated with the development of faith, which, in its turn, becomes the inspiration of every form of higher activity in the self-conscious being. In intercourse with Nature, emotions are aroused which incite to further knowledge, and knowledge in turn plays in different ways upon the emotions. Now any account of a phenomenon in terms of science will appeal to the intellect, but the phenomenon, even the account of it, may also appeal to one of these other aspects of the human constitution. And without the inclusion of these other aspects the account is incomplete. The scientific account may be complete, but it is not the whole account, and in certain cases may be the least satisfactory or important part, *e.g.* in the case of a rainbow or a sunset. From such instances it is not a far step to those other circumstances and events that appeal to, and control, the destinies of man. There is no ultimate difference in kind between the appeal of the radiance of the rainbow and of beauty of character as it appears in some human form.

It is but a further step to consider that any such controlling, moulding, appealing agency may sometimes have at the moment no direct relation with the external world: it may exist simply as an ideal. Yet it may be doubted whether any ideal has ever entered

the human mind as it were out of space, *e vacuo*, unrelated to anything else in the world. Not merely, therefore, must all idealistic impression connected with any phenomenon be taken into account before we can in any way call our account complete. That ideal itself, connected both with the will and with emotion—for an ideal is that which commands the assent of our will and evokes approval—is as much, when entertained, an affirmation as any piece of intellectual knowledge. Our recognition of an ideal is an assertion of its approval by us, it is therefore a matter of knowledge for us—knowledge, let us say, about the conduct of life—and as such not different in kind from any of those views about the physical world that pass for knowledge. And further, every human action as the result of the exercise of will is likewise just such a voiceless assertion. Activities, like things in general, are because of their significance.

Accordingly while that interpretation of phenomena as they are, have been or will be, which corresponds to the scientific account of things—the real as it were—is valid, yet it is not the whole account, and this is furnished by also considering the ideal—that is phenomena as they exercise influence over, or can be influenced by, the human will or emotions. Indeed from the plane of human life this ideal aspect is the more important, for the will to know has its roots in a desire to master the world and make it approximate to what our feelings would have it be. Self-conscious life is a struggle first to decide what ought to be and then to bring that into effect. In this sense the real ministers to the ideal. Naturalism is no competitor, but the servant, of Idealism. Naturalism is true, but it is an incomplete interpretation of phenomena. It is as if a man explained a picture in terms of chemistry and physics and the painter's palette.

Of this incompleteness we find a hint in the particular scientific conceptions themselves, which on thorough examination are found, as Boutroux has expressed it, "to point beyond themselves"¹. It is not the doubts

¹ Boutroux, *op cit* p 262

expressed, *e g*, as to the absolute truth of the conservation of energy ¹ it is that when we examine the latter conception itself we find ourselves driven beyond the purely quantitative (and therefore measurable) aspects to others where this criterion will not help. For these measurements will embrace changes in the physical nature and composition of that which is the vehicle of energy—changes, that is, also in the form of phenomena, and that form is something more than a mere name for a condition or particular collection of measurements which apply to certain aspects only. The same holds true of the scientific ideas of Life and Evolution. Science is continually hinting at that region wherein the religious consciousness finds its satisfaction. Her accounts in proportion to their completeness rise in their dignity, their wonder, and their power.

Between the conclusions of Science and of Religion there can then be no occasion of conflict. In their most characteristic types they have little in common, and in that basal region where they come together, disagreement is out of the question. They do not treat of different planes of phenomena, nor deal with absolutely unrelated series of facts. They are concerned with the same kinds of facts but in different ways. They deal with the same world, but ask and answer different questions concerning it. Science is concerned with the order of events in causal association with similar events, Religion considers events in their infinite relation to the sum total of events.

In her account of things Science has still these very things to account for. In her use of mind as an instrument, she cannot forget that without mind her existence would not be possible. Over and above the symbolical account of external reality there is the mind that appreciates it. Phenomena can have no extra-mental existence though they may well have an extra-human existence. In truth Science corresponds to but a single aspect of Being, and she cannot maintain that the part with which she interests herself is equal to the whole. In man there are other needs, other

¹ Sir Oliver Lodge, *Life and Matter*, p. 22, *infra*, p. 299

driving necessities than that imperious demand for unity that instigates his scientific quest

Religion has her great mission, that of enabling man to overcome his surroundings and himself, and to acquire that peace of spiritual content that will give him the victory over disquieting doubt and temptation and in all this Science can help—Science in so far as she is truth, for it is the truth that sets men free from the prison of their fears. But Religion can never be Science, and still less can Science ever be Religion. Religion deals with the supernatural, it is said—but the supernatural is concerned with the whole world. We talk of the real and the ideal, different aspects of reality but the natural and the supernatural stand to one another in an analogous relation. And our interpretation of the real is modified and governed by our interpretation of the ideal.

To-day the theologian and the man of science can meet and find that they share in a great community of belief. "Religion," said Sir E. Ray Lankester in a Presidential Address to the British Association for the Advancement of Science—quoting from Bishop Creighton—"means the knowledge of our destiny and of the means of fulfilling it," then added, "We can say no more and no less of Science. Men of Science seek, in all reverence, to discover the Almighty, the Everlasting. They claim sympathy and friendship with those who, like themselves, have turned away from the more material struggles of human life, and have set their hearts and minds on the knowledge of the Eternal."¹

¹ Presidential Address, *Brit Assoc Report*, 1906, p. 42

CHAPTER II

THE INFLUENCE OF SCIENCE UPON RELIGIOUS THOUGHT

THE history of the relations of scientific and religious thought,¹ so full at once of instruction and of tragedy, discloses no period in which the influence of the former upon the latter has been greater than during the past sixty years, fitly designated the Age of Science. This influence has increasingly manifested itself in three distinct ways. It is seen, directly, in the modification of theological doctrine as the result of definite scientific conclusions. Men have got into touch with Nature, have learned her order and her laws, and so far as they have seen in them the divine method of operation, have formed more worthy views of the World-Ground of which Nature is a partial expression. Our conceptions concerning man and "the Fall," the relations of sin and death, and God and the world, are not those of mediæval times, not even those of our grandfathers—or ought not to be. In each case a great deal has been definitely added, and what was already there has been purified and clarified. The definite increase and modification are due in great part to the advance of scientific knowledge. Nor has this advance resulted in the disproof of any essentially religious truth. Facts cannot prove a negative. There are millions of stones in the world that show no spontaneous attraction, but that does not invalidate that other fact that the lodestone attracts iron.

This influence of Science upon religious thought is further manifested in the widespread adoption by

¹ Cf. J. W. Draper, *History of the Conflict between Science and Religion*, A. D. White, *Warfare of Science with Theology*

religion of the scientific method The scientific method is, briefly, an appeal to experience and to experimental tests on the one hand, followed by the induction and enumeration of general laws or principles as the result of this appeal The data are carefully recorded, verified, worked over and collated, until the personal element is winnowed out and the residuum of abstract truth is left In her collecting of well-attested data and sifting of evidence, Science has given us an ideal of exactness and has disciplined our thinking This may be illustrated in various ways

(a) In the detailed discussion of any important question, the historical method is now always adopted The thing as it is can only be fully understood in the light of its history Science has long known the value of the examination of life-histories, and theology has applied this method to the elucidation of her organic entities, *i.e.* her dogmas—for if any of them are not living, they had better be discarded—with conspicuous advantage Or the investigation may be more radical Starting from the religious consciousness, we may strive to determine the question of its universality, or what is more difficult, to reach the permanent and unchanging element in its witness Each age has had its theology, perhaps every individual in any age has his own How much has it been coloured by the particular spiritual atmosphere of that age? That it has been so tinged nobody will deny There is the hereditary element, reproduced because it is something living, but there is also the increment due to the pressure, social and intellectual, of the particular period Can these be successfully disarticulated from the original growth, so that we could, working backwards, gradually unstrip the sheathings of each era, like the enclosing leaves of a bud—each of them in some measure alive—till we come to the vital core? The suggestion of such investigation implies the application of a method that is essentially scientific

Such naturalistic examination is often, however, feared, particularly where it affects to give accounts of the origin of distinctive human characters, such as

mind and conscience, that are felt to be derogatory to the characters in question. Yet even if we can successfully give a correct naturalistic account of the rise of the distinctive human characters, the fact remains that we are dealing with a world that harboured such possibilities, and it is difficult to avoid the conclusion that these characters point beyond themselves, and are never *explained* in the fullest account we may give of their history. Why, for example, if we may do as we like so long as we grin and bear the consequences, should such an inhibitive sense ever develop as that of moral obligation, if it did not bear witness to something beyond itself? There could have been no inducement to follow its beckoning in the case of those who had the first experience of its call to self-sacrifice, and perhaps death, because they could not have *known* that it would eventually mean life in greater abundance. They must have felt that the call had relation to some external circumstance, perhaps even to One calling; they must have obeyed, penetrating beyond the challenge, "Ye shall therefore be holy, for I am holy" ¹

Again, it is by the aid of this method that the science of Comparative Religion has been developed. As a result, we now see that all religion, not excepting the religion of revelation, has had a history, that that history has been continuous, and that its successive forms should be investigated in their mutual relations. We may learn how very diverse national and tribal sheathings have protected living cores in no great way dissimilar. Thus we have been led to the recognition of something useful in the world-religions, to the recognition of the fact that they had a function to perform, and that they exerted a wonderful moral influence over men—positions that had not been reached some fifty years ago, views that are the direct outcome of the evolutionary attitude. As a result we are compelled to realise how we must henceforth *think* Christianity always in relation to the whole world, not merely applying it practically to the world's need, but also stating it intellectually in its adaptability to the gropings

¹ Cf R. H. Hutton, *Synthetic Society Papers*, p. 32

of many pagan minds and the scientific witness of the age, and above all saving it from being elaborated merely into a code of Western ethics and ritual

(b) The scientific method has likewise resulted in the application of increased powers of observation and analysis in that sphere where we are considering its action. This has involved a clearer appreciation of what is implied in a demonstration, the bringing of cause and effect into more marked relief. It has also meant that an increased number of factors—secondary causes—is looked for as the explanation of phenomena in the religious as in the natural world. In one sense this is to recede from the standpoint of the Hebrews, who had little idea of secondary causes and to whom God was immediately back of all phenomena. "In the beginning God created the heavens and the earth," and in their opinion He acted in the same direct manner all along. This is essentially the religious idea. But, on the other hand, ours is the gain in knowledge of the marvellous ways of His working, progressively, Kepler-like, we may sometimes be conscious of thinking His thoughts. On this view, involved in the very possibility of knowledge itself, Science is but the unfolding, the revelation of the thoughts of God which it is our privilege and duty to try and follow Him in thinking. It is scientific method that compels us to read our knowledge of Nature into our interpretation of Scripture, in place of the older method whereby Nature was interpreted by traditional conceptions of Scripture.

(c) Again the scientific method is mainly responsible for the present-day critical tendencies that are at work in every department of knowledge. The conclusions of past generations are questioned, examined, refuted, or rehabilitated. Formerly, men were well content to accept statements and facts, theories and solutions on the strength of a great name or institution. To-day that is all changed—our age no longer pays implicit respect to the authority of authority. This does not imply a revolution—the abolition of authority, all that has happened is a modification in the conception of authority. As knowledge grows and civilisation ad-

vances, man has to accept more and more upon authority. He thereby frees himself from his own limitations, and in such acceptance signifies his recognition of special training, special insight, perhaps even special communication. Such massed authority, as representing the supreme pronouncements of the human mind, merits allegiance. Yet the recognition of authority does not mean that the individual is to use his own reason less. On the contrary he must use it more. Whatever the dicta of authority, they have to be verified and justified, and that can only be done at the bar of Reason—a Reason that becomes increasingly capable in its particular business. Authority can never be a substitute for the individual experience, it should not supplant but rather supplement it. In that spirit which considers no name too great, no reputation too high to prevent the statement or hypothesis lying under its shadow from being dragged out into the fierce light of modern expert criticism, we may see the influence of the scientific method upon religious thought. This compulsion of truth sometimes looks like sacrilege, and it is just here that the scientific method is especially helpful in its insistence on the preservation of an open and impartial judgment towards subjects still under debate. If the judgment is adverse, the scientific worker discards his cherished ideas, even although sorrowing, for the sake of truth, and if substantiated, he embraces them again with the joy of recovered treasure. Now there is probably no field of human inquiry where a greater mixture of essential and non-essential has accumulated than just the general field of religion. And surely there is no sphere where sharper distinction should be drawn between what is known and what is inferred, between what is and what seems to be.¹ The influence of the scientific spirit is seen in the stripping off all round of non-essentials, in giving them their right value, and adjusting them to truths more newly won. The natural theology of one age fails in its appeal to a later age. The piety of Paley still impresses men, but not his premises or proofs. For not merely has Nature changed,

¹ Prof. J. M. Coulter, *American Journal of Theology*, vol. III p. 645

but what is vastly more important to us, our understanding of her has changed even more. It could hardly be that the old appeal should hold. Any such spirit of inquiry need not be feared, for, in the language of the unknown writer to the Hebrews, it merely "signifieth the removing of those things that are shaken, as of things that have been made, that those things which are not shaken may remain" ¹. On the contrary, it is a movement to be welcomed, for it is at once hopeful and necessary, so much so that even of those regions where its work has been most radical (as *eg* Old Testament criticism, where it may leave us as a result with but a portion of a book conforming to our earlier opinions of it), we can say fearlessly and truthfully, though mayhap paradoxically—The half is better, greater, than the whole.

In this connection, scientific procedure suggests in analogy an influence that may yet be more definitely exerted. Of nothing is science more proud, on nothing is she more dependent than her experimental method. Experimental Religion was a word of our fathers containing a truth which is ever being realised afresh—practical experience of the power of religion on the individual life. Experiment differs from mere observation in that the observer instead of merely waiting for favourable conditions, as *eg* the astronomer and palæontologist are compelled to do, himself in great part arranges the conditions of the phenomenon of which he desires experience. Others of them are arranged for him in the fundamental laws of Nature. A good experiment is one which teaches us more than a single isolated fact, one which enables us to predict or generalise, for without generalisation prediction is impossible. Religious experience, no less than any other kind of experience, may be acquired under conditions that lend themselves to arrangement and repetition. Concerning these conditions the learner can only go to those who have already made experiment. For if there is an experience in religious matters as well as in things secular, and if in the case of the latter we go to the

¹ Heb xii 27

expert for information and for stimulus, then it would seem to be the wise and proper course to seek out the men of moral genius, and from them learn the best that they can teach us. How can a man otherwise begin to understand that for which he may feel that he has no initial affinity? And if it appears that such experience culminated in One who more than any other claimed to know the mind and will of God, and has justified that claim by the unceasing inspiration of His life, then it would seem the height of folly to disregard His teaching and to refuse to learn of Him¹. Now that teaching is, in a very real sense, experimental². In many instances it consists of definite assurances of results provided certain conditions are followed,³ and the predictions and generalisations of the most competent experimenters have been throughout the ages a source of joy and encouragement to themselves and to their fellow-men.

The influence of Science upon Religion may lastly be seen in the gradual growth of an atmosphere, an attitude of mind, which may be called the scientific temper in Religion. This naturally results from the use of scientific methods, but in differentiating the two we imply something more subtle and difficult of definition. The breadth of outlook, the hankering after causality, the desire to test all things and hold fast to that which is good, the freedom from dogmatism, the patience under mental tribulation, the perseverance in the face of temporary failure and defeat, the wistfulness that will yet ponder for years over an apparently insoluble problem, the determination that again and again traverses the field of the known to verify or pick up some grain of knowledge that has been overlooked, the sympathetic regard for his brother's travail, the secret and immovable content with the universe, the firm assurance that it is sound and solvent at the core—it is in traits such as these that we may, and increasingly do, recognise the scientific temper in the religious man. But most specifically may we think of that spirit of

¹ Cf. Wilfrid Ward, *Synthetic Society Papers*, p. 19

² Cf. John vii. 17

³ Cf. John xv. 7, 10

adventure without which Science could not enlarge her borders, and through lack of which religious life has stagnated not merely in many an individual but even in whole communities. Few great scientific discoveries have been made directly and immediately, for the most part they have been the result of accident, by-products of some intellectual and experimental enterprise that definitely set out in another direction. "The process of seeking out analogies and resemblances wisely," says Mivart,¹ "is perhaps the special characteristic of a sagacious man of science." Very often the man of science is as a fisherman throwing out the bold line of his hypothesis or speculation over some region of the river of experience that flows continually by him. He has reason to believe that there are fish in that particular stretch, some one else has got a fact or two out of it. And he throws out his line, but the fish are not amenable. He then alters his hypothesis—changes his fly as it were—and after repeated attempts and days of patient endeavour, during which he finds that none of the accredited flies are of value, he makes up that particular new fly that compasses his facts—he enunciates the hypothesis that fits and suits the facts so that he can, as it were, control and draw them in to his side. Now, in the religious life has there not been something very like this? How else can we describe the feeling after God in all generations, if haply they might find Him, this setting of the soul in a particular direction? Even towards that revelation which was given in Jesus Christ of the loving Father-heart of God and of all that concerns His relationship to the sons of men who are His children, a man could adopt no more fitting mental attitude, while the humble but adventurous and expectant soul that does the will of God will find fresh knowledge—not merely knowledge that is already the experience of others though new to itself, but absolutely new knowledge—pouring in on every hand concerning, *e.g.*, the nature of God, who does become known to us in certain of His attributes as an evergrowing revelation. To "follow on to know the Lord" is a supreme duty

¹ *The Groundwork of Science*, p. 96

as well in the interests of man's thought as of his soul

If in concrete illustration we might endeavour to imagine a scientific man at work upon his creed, assuming that he has the will to believe or the will to doubt, or at any rate is not disposed to regard the theistic attitude unfavourably, we may be sure that he will begin by telling us that no thinking man begins with a creed, he arrives at a creed. He will also tell us that he is not afraid to re-examine his creed critically every day, science waits no three hundred years for oecumenical revision. The man of science believes nothing to-day in the strict realms of science that he is not prepared to surrender to-morrow, should sufficient reason be shown. He will further lay stress on the fact that religious, and more particularly theological, thought is tinged—perhaps a stronger word should be used—with anthropomorphism. That, of course, cannot be helped, it is in part a result of the conditions governing the undertaking. But he will insist that we be thoroughly conscious of this anthropomorphic bias, and set some check upon it. He will also have us definitely recognise that ultimately we are all agnostic in a sense. God is unknowable in the exhaustive sense. The man of science will tell us all he knows about his department, and then he will take Job's words and say, "Lo, these are but parts—the outskirts—of His ways, and how small a whisper do we hear of Him¹ but the thunder of His power who can understand?"¹

He will also, in his honesty, probably let us know that there are certain moods—although a mood in itself is never a philosophy—certain environments, in which he would find it easier to entertain a theistic interpretation than in others. Men do not believe equally intensely all the time. There are differences in the degree as well as in the range of men's faith, religious or scientific. Of some things they are more sure than others, and many are the influences, including sometimes even the infectious strong faith of another, that cause these differences of degree. He will ask

¹ Job xxvi 14.

you to read such a book as Maeterlinck's *The Bee*, or wander through the streets of earthquake-stricken Messina, and then try and do a little theistic thinking. God, if the Nicene Creed is right, is responsible for the bee community—for those features that shock our moral sense no less than for those that excite our wonder. All things are ordered by the divine Thought or Will or Reason, and in that bee community we see a part of the divine economy. There He is working and realising as in the circuit of the planets, and in the lives and hearts of men. For what are God's works of Providence? In the words of a famous catechism, "God's works of Providence are His most holy, wise and powerful preserving and governing all His creatures and all their actions,"—*all* His creatures and *all* their actions—the plesiosaurus of other days, you and me and the bee. We can divine in part, and we can believe, sometimes indeed we are apt to let the rest of the redemptive system outlined in the Scriptural Catechism obscure our appreciation of this central truth—the broadest generalisation of them all, if it be true—that God is exercising a continual *providentia*, a holy, wise, and powerful governance over the lives of all His creatures. But we must not shut our eyes to facts, and such an incident in the social history of the bees as the yearly massacre of the drones gives us something to think about. There is no doubt that everything is apparently run on a system of monstrous waste, and we have got to try and find a rationale of it. We can imagine that things might have been otherwise. Such imaginings are our ideals, which, unrealised, have filled men's minds with saving yearning and a divine discontent. This yearning finds expression in works so far removed from one another as H. G. Wells' *Anticipations* and portions of St. John's *Apocalypse*.

Our man of science will further tell us that while carefully bearing in mind the fact that the study of the sciences can never give us any generalisation that is more than probable, yet for practical purposes he divides a creed—your creed or his—into three compartments corresponding to the terms, Knowledge,

Belief, and Over-Belief¹ Under Knowledge, he will include for himself all natural knowledge "The universe is governed by thought," he may say, "assume this, if you cannot straightway grant it Accordingly, the world admits of interpretation in human, *i e* universal thought" So he will begin his creed "I believe that one and one are two," and continue through all the sphere of knowledge until he has brought in the latest scientific discovery Such bare recital, however, will not necessarily include all that he may claim to know He may feel assured, *e g*, that God loves His Creation—the Creative Energy has delight and complacency in maintaining the succession of the seasons, flowers, and human beings, and takes pleasure in their delight, and that too without any incompatibility with the death of the individual or even the extermination of the species He might maintain that to him it is intuitionally revealed that mere Being is a good, that in any form it is worth having, that not only man but beasts and flowers, and mayhap the crystal, have a certain awareness of it, and satisfaction simply in existence

"For love we Earth, then serve we all,
Her mystic secret then is ours
We fall or view our treasures fall
Unclouded, as beholds her flowers

Earth, from a night of frosty wreck,
Enrobed in morning's mounted fire,
When lowly, with a broken neck,
The crocus lays her cheek to mire"²

He might suppose the very elements on cross-examination saying "It is worth while existing, and we are content to be here doing the will of God" Which if it were all true would mean that there is a very real sense in which there is no waste, "nothing walks with aimless feet" He might think of the myriad pollen grains that have failed to waken an egg-cell into fulness of life, yet out of their very *joue de vivre* reflecting, "No, we are not wasted, none of us, and we are all quite

¹ Perhaps more expressively rendered in the German equivalents—*Wissen, Glaube, and Aberglaube*

² G Meredith, *The Thrush in February*

happy" And if all created things have this *joue de vivre*, this *joue d'être*, then *a fortiori*, he might argue, it is so with God But such reflections would not fall within his category of experiential knowledge

Under Belief, the man of science might include, *eg*, personal immortality He might believe in the immortality of his father, of his mother, of himself, for various reasons, although he does not know it to be a truth, and does not know any one who does, he maintains that up to the present it is not a matter of Knowledge (*pace* the Psychical Research Society), nevertheless it cannot be disproved, which will differentiate it from all Over-belief Having entered this region of belief he might even add a corollary, as *eg*, The immortal spirits of those whom we love, are, and will be willing to assist us Christ, my father, my mother, each according to their ability in this unseen world, wishes me well, and will do me all the good they can, and in the degree in which each of them is co-extensive with God will be their power to help me

Under Over-belief he will say that a person may cherish any belief that he thinks necessary or helpful to him in maintaining his Belief Thus it is Over-belief that leads many people still to maintain that Moses, David, and Isaiah wrote all of certain works associated with their names Some are perfectly aware that they are hardly warranted in so believing it is an over-belief on their part Here the true man of science will not chide, but he will say, "Go on, believing, if that is necessary to your Belief, but do not abandon the search for truth, and in any case, do not think hardly of those who cannot share your belief If that belief is sincere, and not something held for social or ulterior selfish reason, we shall one day find that that which divides us is less vital than that upon which we are agreed" One remarkable form of Over-belief is the doctrine of Transubstantiation, namely, that under certain conditions, and in a certain place, a wafer of bread is changed into the body of Christ Here the true man of science will not scoff, but perhaps will say, "Go on believing for the present, if that is necessary to your

Belief, and God be with you but examine and re-examine the reasons for your acceptance of this doctrine "

Hitherto we have been discussing the scientific temper in religion, but there is the complementary side, which if not so obvious is at least as imperative—the religious temper in science. In proportion as the two tempers grow, there will come that final recognition of the relation of scientific and religious thought as twin expressions of fundamental truth. The revelation of order and of power as of the very essence of the world-process, the recognition of something akin to reason rather than to caprice as operative at the core of things, the realisation of human participation, direct and determinative, in this terrestrial mill, must profoundly influence not merely man's highest thought and deepest feeling, but every endeavour that is made to increase the sum of human knowledge. Under this conception of the religious temper in science would fall to be included that sense of wonder, even of reverence, that is strong in the heart of every scientific man whose eyes are really open. As he attempts to probe the secret of the constitution of matter, as he endeavours to comprehend the vital processes that are in evidence in the intra-nuclear chromosomes, as he reflects upon the evolutionary outlook with its vast perspective of progressive achievement, he is filled with a sense of wonder which surely is not far removed from the worship "in spirit and in truth" "He that wonders shall reign, and he that reigns shall rest" ¹ Nor shall his rest be troubled by any apparently humbling discovery even in the natural history of Man, for he will have realised that the whole process is of God.

¹ An extra-canonical Logion or Saying of Jesus, first known as quoted by Clement of Alexandria from *The Gospel according to the Hebrews*, now recovered in its original form, cf. *The Oxyrhynchus Papyri*, Part IV p. 4

CHAPTER III

PRINCIPLES OF BIOLOGY

BIOLOGY is the science of life in the widest acceptance of that term. It deals with the general conclusions relating to life that may be drawn from study of the structure and activities of all living things. As such it is as intimately connected with the activities of the human organism as with those of the malarial parasite that passes a stage of its existence in his blood. It concerns itself with every feature in the apparently passive manifestations of the oak tree's vitality, as well as with those of the active gall-fly, whose developing eggs stimulate the gall-formations upon its leaves. In popular thought, life displays itself in two great, apparently unrelated, fashions, corresponding to the animal and vegetable kingdoms respectively—types which are undoubtedly sufficiently distinctive and apart in their most highly developed representatives, but which, as they are studied in a descending series, are found to become ever more simple, until forms are reached which, from the point of view of morphology, are practically alike in the two instances, although still differentiable physiologically. While eventually, certain forms fall to be considered in respect to which the last differentia ceases to hold, and no unequivocal judgment can be passed upon their animal or vegetable nature. Yet let it not be imagined that to study life in these simpler forms does anything more than eliminate certain secondary constituent elements. "Livingness" in itself is not more intelligible in the amoeba than in the elephant.

The initial question of Biology is the nature and characteristics of living matter—the determination of

that wherein "livingness" consists. Conceivably, this may be best attempted by consideration of the simpler forms of life yet to solve the problem of their "least common measure" does not necessarily mean that we have determined the unit of life. Wherein, then, does "livingness" consist? Possibly we should instinctively reply, movement—movement, either purely locomotive, or such as is involved in the maintenance of the functions of nutrition and reproduction. Yet in the case of any seed or egg, life is somehow there, though we see no movement. We can ask about either the seed or the egg, Is it alive? or Is it capable of living? but these are obviously two very different questions. It is known that if dry seeds be kept for a long period in hermetically sealed jars they cease to respire, failing to manifest any chemical production of CO_2 , one of the great signs of life. Hence their chemical answer to the question, Are you alive? is, No. But does this answer necessarily imply that they are dead? And again the answer is, No, for if released from their prison and placed in suitable conditions they will germinate and produce new plants. "So that a seed, in so far as it does not manifest chemical change, is not proved to be living and, inasmuch as it germinates, is proved not to be dead"¹ Of course, the usual escape from this dilemma is to say that the seed is in a state of latent life, during which, we may suppose, there is a complete suspension of all the chemical changes that are characteristic of the living state. But a more correct statement is that we have no means of chemical investigation sufficiently refined to reveal to us the infinitesimal changes that are probably going on in the apparently dormant seed and it is further possible that chemical change may be almost completely suspended for a time (e.g. by low temperature) without that arrest being necessarily final. The reason for believing that infinitesimal changes are going on in the seeds, which our methods are too crude to detect, is simply the experience in the first place that seeds that are kept for a long time do wear out, and that the percentage of seeds that

¹ A. D. Waller, *The Signs of Life*, p. 5

germinate and grow gets smaller and smaller the longer they are kept "The deterioration is more or less rapid according to the nature of the seed and the character of its protective coats, but in every known instance there is deterioration sooner or later,"¹—deterioration, *i e* change, chemical change We do not know, but it is not unreasonable to suppose, that the change is of the nature of a tendency towards stability on the part of the seed molecules as the result of the lack of specific stimulation A stage is reached when the ability to respond finally vanishes Similarly, in the contrary direction, the process of growth when once begun cannot be arrested it must proceed, or the organism will disintegrate immediately Life is a process rather than a condition When once, as in the case of the developing egg, a certain favourable temperature has disturbed its statically arranged molecules, proper energy must be furnished for continuing the process, or the whole structure dissociates and falls apart, and we say that the thing is dead

Further, it has been shown that the vitality of seeds can be tested by the galvano-metric method (electrical changes being taken as the token of chemical changes, which are in turn a sign of life), so that in addition to the question, Are you alive? we can put the question to the seed, How much are you alive? and learn its answer in terms of electric units Plants are obviously not as alive as animals, and in the case of the seed, different degrees of vitality will be shown corresponding with its age At the same time we have made little advance in our inquiry as to wherein "livingness" consists For the simple truth is that we cannot tell what life is Yet if we cannot tell what life is, we can state what living things do It is possible to make a series of statements descriptive, if not definitive, of living things

1 All living things consist of a colloidal substance called Protoplasm As seen in the simplest plants and animals, it is viscid and translucent, generally colourless, immiscible in water, and yet composed of it some-

¹ Waller, *op cit* p 6

times to the extent of 90 per cent. Chemically analysed, after treatment by reagents, which rob it of its essential character, it is found to consist of various organic and inorganic compounds composed of carbon, hydrogen, oxygen, nitrogen, sulphur, and phosphorus, together with traces of various salts and other substances¹. Phenomena like the precipitin reaction suggest a certain specificity in the protoplasm of different groups, and indeed of individuals within the same group, yet in its simplest and most generalised form, this complex of proteins,² carbohydrates,³ and fats⁴ exhibits such a variety of qualities that the mere chemical synthesis of protoplasm is no longer a useful conception. As Prof Macbride has so clearly expressed it "When a mixture of substances is enclosed in a test-tube definite reactions are set up which progress towards a state of eventual equilibrium, and an end-state is reached with a mixture of different substances and in different proportions from that with which we started. In protoplasm, on the contrary, the typical nature and proportions of the mixture must somehow be maintained even in spite of increase in quantity,"⁵ and of this we can reach no explanation by any purely physico-chemical analysis. The distinctive materialistic fallacy lies in the supposition that because the organic is chemically decomposable into the inorganic and has the same atomic composition, therefore the latter can give rise directly to the former.

Chief amongst these characteristic qualities is the fact of its organisation, by which we mean the persistent

¹ Reinke found that in the case of *Fuligo varians* (Flowers of Tan) the ash of the burnt protoplasm contained the following elements: chlorine, sulphur, phosphorus, potassium, sodium, magnesium, calcium, and iron.

² $C_{700}H_{1700}N_{100}O_{918}FeS_8$ = probable composition of a molecule of the hæmoglobin of blood. Proteins, e.g., the albumin of white of egg, are the most characteristic compounds of carbon found in living matter, they consist invariably of the elements C, H, O, and N as a basis, the nitrogen being the distinctive feature.

³ These consist of C, H, and O in various combinations, and are typically represented by the different sugars and starches.

⁴ These are composed of the same elements as the carbohydrates, but in quite different arrangements. They represent a synthesis of a fatty acid and glycerine.

⁵ *Nature*, vol. cxi, p. 74.

and active maintenance of a co-ordinated structure. Structureless protoplasm does not exist, the disclosed homogeneity is only apparent. Careful examination of protoplasm, even in that specialised condition in which it constitutes the cell-nucleus, shows that under the morphological aspect two main constituents are present, one of which, the more liquid ground substance, is continuously distributed throughout the meshes of a more active and, at the same time, firmer reticulum, as the second constituent is called. Holding a kind of intermediate position between true solids and true liquids, protoplasm under the highest magnifications seems at times essentially liquid, or rather a mixture of liquid colloids showing an emulcent structure, in which the firmer portion forms the walls of separate chambers that are filled with minute, closely crowded drops of the more fluid portion¹. The reticular appearance might then be supposed to be of the nature of an optical illusion—an expression of alveolar structure. On other occasions, however, even the same living matter will reveal the presence of extremely delicate, though coherent, threads which extend through the more liquid ground substance, either forming an uneven but continuous meshwork like the fibres of a sponge, or consisting of disconnected threads and their branches. Further, the clearer outer layer of protoplasm in a cell (ectoplasm) differs in many characters from the darker and more granular inner portion (endoplasm). Accordingly we are compelled to think of the protoplasm of different organisms, and even of the same organism at different points, as varying in its material, composition and structure—differences that are probably largely due to variations in molecular arrangement. There is no universal mode in the structure of protoplasm, it is polymorphic, but possibly the different types represent different states and phases of its development.

¹ With singular skill Butschli succeeded in preparing artificial emulsions which show a striking resemblance to actual protoplasm in structure and in movement. Even more arrestingly, I éduc (*The Mechanism of Life*) has produced osmotic creations that temporarily show features analogous to characters of living forms. His general conclusions, however, seem to be in advance of his data.

In virtue of this organisation the attempt is continually made to offer a complete explanation of the living thing in terms of mechanics. The living organism is certainly more of a mechanism than of a chemical compound, and its activities will find a better explanation along mechanical lines than in the mere consideration of its chemical nature, yet even here imperfectly. Doubtless the properties of the living cell may in the end be traced to chemical forces, just as in the case of the activities of the steam engine, yet no one will maintain that chemical forces explain the motion of the steam engine. Superficial resemblances that disclose themselves, in their greater or less completeness, simply serve to hide the critical points of difference. Thus it is obvious that in either case suitable fuel or food requires to be more or less continuously supplied—and all fuels are organic substances—that this food or fuel is subjected to definite changes in the interior of the mechanism, in the course of which heat is evolved, and that waste products are formed. Yet the living organism is unlike a mechanism in various respects.

(a) The organism is itself continually being changed in the course of its automatic developmental activity. The engine may be said to consume the fuel supplied to it, but it does not incorporate it in its own substance. The food, self-procured, of an organism is in a sense its fuel, but it becomes directly transformed into the machinery that is at work.

(b) The organism has a power of self-adjustment and regulation amounting to self-preservation which has not been added to it from the outside, and is not a necessary property of the substance of which it is composed. The activity of a machine, on the other hand, is of no use to it in the line of preserving its integrity. In this feature of adaptability we seem to get on the trail of the leading characteristic of life. In short, the changes can only be understood when regarded from the point of view of an inherent capacity to maintain the normal condition. In the course of certain experiments conducted with the object of determining the effects of low atmospheric pressure at the top of Pike's Peak, Colorado,

Professor J S Haldane was able to confirm the idea that mountain sickness was due to lack of oxygen, and further found that the body in the course of a few days tended to return to the normal. The nausea and other associated features of the condition disappeared, for "the lungs had begun to secrete oxygen actively into the blood and raised its saturation with oxygen. At the same time the lung ventilation was increased and the partial pressure of oxygen in the alveoli was raised correspondingly, and, thirdly, the oxygen-carrying power of the blood was raised by an increase in the number of the red blood corpuscles. By these means the oxygen supply to the tissues was restored to about the normal"¹

(c) The organism has a certain regenerative power. In its case that which is consumed during activity is the actual machinery, and within definite limits food both fills up the gaps left in the mechanism and repairs any damage it may have sustained, whether self-inflicted or otherwise. The coal supplied to an engine does nothing to repair its tear and wear, nor can the engine execute its own repairs. It is here in particular that the mechanical hypothesis gets into difficulties. Experimental data go to show that portions of certain organisms (*Hydra*, *Clavelina*) separated at any point in the early stages of development have the power of developing into the whole, if indeed on a reduced scale. Interpreted on the mechanical hypothesis, this would mean that in any selected portion of the whole which is, *ex hypothesi* a mechanism, there is ensconced a mechanism that will reproduce the whole, and the proven equipotentiality of these portions means a multitude of such mechanisms localised precisely as the experimenter chooses to divide up the organism. The same conclusion follows from the fact that individual cells of the sea-urchin (*Echinus*) egg shaken apart at the 16-cell stage develop into miniature complete embryos, one-sixteenth the normal size. One-sixteenth of a watch is no use as a watch, one-sixteenth of a sea-urchin at a certain stage may be useful as a sea-urchin. Again, the simple fact

¹ *Brit Med Journal*, No 2654, p 1300, cf also his *Respiration*

that in certain cases of regeneration, various tissues working to a great extent independently, combine harmoniously in a proportionate whole, which is, further, the same, although experimentally attainable by different developmental routes, is more than sufficient to refute a purely mechanical interpretation of ontogeny¹ Indeed the consideration of the organism as a living whole almost amounts to a new category²

(d) A machine is constructed to execute a certain limited number of functions, and these it perpetually performs in the same way the organism's range of activity is as wide and varied as its methods of operation In particular no explanation could be afforded along such lines of the phenomena of autolysis,³ whereby some of the chemical reactions associated with life are still observable in cells subjected to treatment which must go far to destroy their structure

(e) The organism can completely reproduce itself by means of parts thrown off from itself there is nothing analogous to sexual reproduction in the inorganic kingdom The simple fact that in reproduction the individual has a definite origin in time and space, seems to dispose of any fundamentally mechanical interpretation of inheritance Between the idea of the fertilised egg-cell and its myriad divisions resulting in a whole wherein again are segregated cells that have the power to repeat the process, and anything that we can fairly associate with the word machine, there is no correspondence We cannot imagine a machine that can subdivide continuously, retaining its wholeness, and yet can duplicate itself in certain of the products of self-division To have such an entity in the living organism, and then apply to it the term machine, is simply to play with words

(f) The activity of a machine is usually the sum of the activities of its constituent parts, but in the case

¹ Cf Hans Driesch, *The Science and Philosophy of the Organism*, vol 1 pp 158-161

² Cf Prof J S Haldane, *Mechanism, Life, and Personality*, chap

III

³ Cf F Czapek, *Chemical Phenomena in Life*, pp 14, 15

of the organism it is something more, for its living unity is not merely represented by the sum of its organs, but involves a certain subtle interplay and mutual influence of its constituent activities. To express the total activity of an organism by the sum of all its separately analysed activities would be to omit all recognition of the relation which unites—the rebounds, so to speak, which pass between—the several activities. There may be a mechanism of isolated parts, but in many cases they are detachable from the whole without vital damage, whence it would seem that the mechanism of the whole must be different, and at any rate indivisible. But this particular mechanism, in itself constantly changing and yet extending itself through time, is incommensurate with anything to which that term is usually applied.

In short, the differences are so great that unless they are steadily held in view the analogy becomes positively misleading. To attempt to explain the living organism and its activities in physico-chemical terminology is the scientific ideal, notwithstanding the difficulty of seeing how by the application of physico-chemical methods, anything other than physico-chemical results can be secured. Even in that most difficult of all realms, the study of nervous process, Professor Gotch is perfectly entitled to claim that nervous activity "does not owe its physiological mystery to a new form of energy, but to the circumstance that a mode of energy displayed in the non-living world occurs in colloidal electrolytic substances of great chemical complexity"¹. On the other hand, to pretend that even an approximation to sound explanation along these lines has already been reached in general or in detail is mere myopia, and perilous at that, seeing that the very principles of mechanics themselves are far from being satisfactorily determined. And in any case between that which exhibits spontaneous evidence of mind, and that which does not, there is an enormous difference which cannot be resolved by the mere application of the word mechanism to both.

¹ *Brit Assoc Report*, 1906, p 716

The above discussion may then be considered as having indicated the relation of life to matter. The mere fact that the first touch of the chemical reagent in the analysis of protoplasm robs it of its distinctive character, shows that life is not material. We know life only in association with matter, yet it is not matter. A cat weighs no more or no less after the loss of its proverbial nine lives than it did in life. If life were material, then *ex hypothesi* it ought to weigh more in life than in death. On the contrary, an equally false impression that dead things weigh more, instead of less, than living things, is preserved in the popular expression, "a dead weight." Life, then, is not matter, nor is it exhausted by the concept of matter. In itself it occupies no space. It has no weight as we know gravity. It may be figured as the flow of something energetic—a procession. Life is essentially labile, yet "phasic or oscillatory in character."¹

2 All living things exhibit a directive control over energy which leads to its further availability. They are able to transform energy in their own interests, for their self-maintenance.

These statements deal with the relation of life to energy—in some ways the most complicated of all the problems that fall to be considered in this connection. In comparing what we know of life with all other forms of energy, we realise in the first place that the origin of the latter is under command in a way that is not predicable of the origin of life. A man strikes a flint and steel together, and so produces light and heat as often as he cares to repeat the operation, but he has no ability to treat non-living substances in such a way as to get life out of them. He can tap all the other forms of energy at any point. He cannot do so with life. Numerous experiments prove the transformation of energy and the ease of this transformation, but as yet there has been no hint of the direct transformation of any known form of energy into life, or *vice versa*.

Nevertheless, living matter is able to effect such transformations. It is, in fact, the seat of continuous

¹ B Moore, *Biochemistry*, p. 1

transformation of energy In these transformations there is nothing that goes contrary to the fundamental laws of the conservation of matter and of energy the potential energy in any food can be calculated, and the value found unimpaired in some type of equivalent work done or heat evolved But this does not mean that there is nothing distinctive in connection with these transformations Certain physical and chemical characteristics abide with the organism in death as in life, but when the typical energy phenomena are no longer in evidence we say that the thing is dead Life, then, has to do with energy, but is not most helpfully conceived of as energy, or even as a specific kind of energy¹ Its characteristic is seen in the way in which that energy is directed and controlled The difference between a living and a dead cat is that the former is able to direct its energy into paths which are impossible for the dead animal with its equal stock of energy the sum of energy is in no way affected The energy of the dead cat flows along paths which are determined by external agency, and very quickly a state of equilibrium is reached the energy is dissipated by heat radiation and slow combustion of the tissues—we can tell exactly how The energy of the living cat flows along paths which are only indirectly determined by outside conditions, and we can only within a wide range of probability predict what particular form the expenditure will take—say how the cat will jump Every living thing is a centre at which energy is being constantly transformed, a centre, further, at which the otherwise universal tendency to degradation of energy is resisted But it is more It also acts as a directive channel along which energy can flow to accomplish specific work as long as the organism is alive it is continually

¹ B Moore, however, introduced the term "biotic" energy to indicate that living structure shows "a type of energy *sui generis* as are each of the inorganic types," and possessed of its own set of characteristics (*op cit* p 18 and *The Origin and Nature of Life*, pp 225, 226) Even more interestingly J M Macfarlane has worked out a theory of a progressive scale of relationship and condensation in various types of energy (*The Causes and Course of Organic Evolution*, chaps 1-vi)

disturbing the equilibrium which should otherwise arise between itself and the environment and within its own elements. Life is unceasing, directive, and selective¹ control of energy like some invisible charioteer it stands athwart a complex of moving forces, constraining and controlling them. But it is also accumulation of energy, *eg* in specific tissues, and a transformation of it leading to further availability. The organism up to a certain stage appears to be continually gaining energy at the expense of the environment.

There are, however, other controls of energy temperature, *eg*, controls its passage in the form of heat from the warmer to the colder body. But this passage involves not merely degradation in that particular form. Hibbert² brings out very clearly that the difference in temperature is a determining factor, and that in any calculation of work done it will find a place, whereas it is impossible to show that life is a factorial element in any calculation of the work done by a living organism. The nearest parallel, yet hardly a parallel, would be in the unique characteristic of reproduction, when, owing to the accumulation of energy, it may reasonably be conceived that the control or potential factor exhibits itself in the process of division. This control is superlatively seen in the development of the segmenting egg to its predestined goal in the typical adult form. Accordingly, we conclude that after the methods borrowed from the analysis of inorganic nature are exhausted, there is a residuum of fact which is untouched by them, *viz* the directive control and co-ordinated adaptation of every element of its activity by the organism to its own end. The biological whole is greater than the sum of its physical or chemical parts. And it is no objection to urge that we are not objectively aware of this peculiar control (*ie* it is not located in any particular organisation), for the same is true of all physical actions, as *eg* gravitational attraction. Life is known to us as control and guidance of energy, interacting with matter in ways which if not yet wholly

¹ In the sense that it selects this or that mode of attaining an end

² W. Hibbert, *Life and Energy*, p. 50

56 SPIRITUAL INTERPRETATION OF NATURE

intelligible to us, are clearly not entirely covered by what we know of its physico-chemical properties

3 All living things are characterised by cellular structure. Life, that is to say, so far as we know it to-day, appears in one typical form—that of the cell. As to how or when life first appeared, we are still very much in ignorance. But the relatively highly organised condition of even the simplest cell makes it increasingly probable that life in its primal forms was molecular in character. Further, every advance in appreciation of the close relation between the organism and its environment whether organic, or more particularly in this respect, inorganic, together with the realisation that the inorganic has had a developmental history as well as the organic, makes it philosophically improbable that the passage has taken place at any other than the one period at the dawn of Archæozoic (Pre-Cambrian) time when the environmental conditions of temperature, chemical complexity, etc.—so different from those of to-day—first permitted it. At any rate we have to-day no evidence of the origin of life except from pre-existing life, and no form of life once extinct has ever again appeared. The stage between the relatively stable inorganic colloid and the more labile organic colloid is one in which the differentia is found more markedly in the field of energy, and the capacity to absorb and be transformed by it, with resulting complexity of structure, than in any other consideration.¹

To-day, however, it is a matter of observation that the bodies of every form of life, plant or animal, are commonly composed of one or more minute structural units known as cells. All organisms, and their constituent parts and organs, consist of cells and of cell products, and in the case of the higher forms of life, the size and shape of the cell are more constant than the size and shape of the individual. The body is a mosaic rather than an asphalt, but the cells are in communication, unisolated by cement. Traces of the primitive

¹ For a further discussion of this issue see *Man and the Attainment of Immortality*, pp 16–20, J Costantin, *Origine de la Vie sur le Globe*, B Moore, *Biochemistry*, pp 32–37

asphalt are however sometimes preserved, as in the vertebrate retina.¹ From the viewpoint of this cell-theory, the animal kingdom (as likewise the plant kingdom) may be regarded as an ascending series at the bottom of which will be put those forms that are unicellular—the Protozoa. Next above them, although essentially of them, come forms that are mere balls or

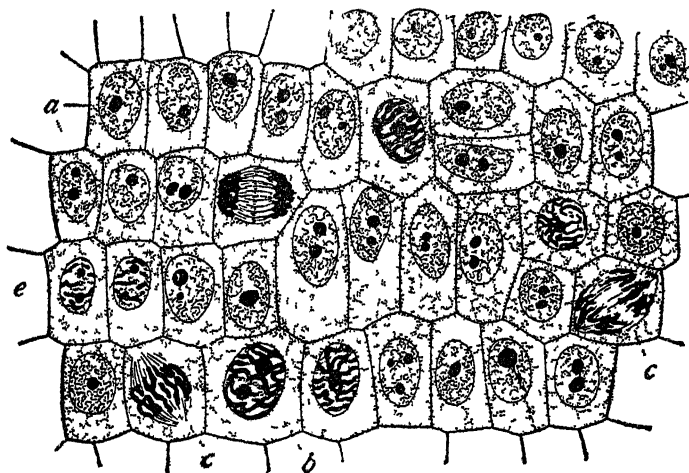


FIG 1 —GENERAL VIEW OF CELLS IN THE GROWING ROOT-TIP OF THE ONION FROM A LONGITUDINAL SECTION ($\times 800$) —(a) Non-dividing cells with chromatin-network and deeply stained nucleoli, (b) nuclei preparing for division (chromatin in form of continuous thread), (c) dividing cells showing mitotic figures, (e) pair of daughter-cells shortly after division (From Wilson's *The Cell*, by kind permission)

colonies of cells, e.g. *Volvox globator*. Thereafter we reach the sponges, where tissues, *i.e.* aggregates of more or less similar cells performing a single function in common, are, as it were, in the making. Next come the simpler members of the Coelenterata—mere two-layered sacs of cells, with hints of organs, *i.e.* higher complexes of tissues devoted to one or more specific

¹ Cf H M Bernard, *Some Neglected Factors in Evolution*, p 222 et seq

functions, and so we arrive at those higher forms, the substance of whose skin, bone, or muscle is not homogeneous, according to the naked-eye impression, but with the help of the microscope is usually resolved into aggregates of cells. And it may be here remarked that Ontogeny discloses the remarkable fact that every one of these higher forms, in its individual life-history, passes through a broadly corresponding series, of which the first stage is likewise a single cell, the fertilised ovum. Palæontology, as interpreted by Evolution, teaches the further striking fact that what is thus true of the individual history holds likewise of the history of the race, which began in the farthest æons with the simplest forms and progressed till it culminated, physically and spiritually, in man.

But in addition to thus furnishing us with a valuable point of view from which to regard the organic world in relation to structure (Morphology), the cell-theory performs a similar service from the point of view of function or activity (Physiology). The cell is not merely a unit of organisation—it is a unit of function. In every protozoon the vital functions—locomotion, respiration (or whatever corresponds to it), absorption of food, digestion, excretion, which in the higher forms are distributed amongst different cells or organs devoted to the discharge of these specific functions—are all performed by the single cell. On the other hand it must be as strenuously maintained that the cell is not an absolute unit, and is as decomposable into lesser units as it is aggregable into elements of a higher order.

Besides the more generalised protoplasm that constitutes the cell-body proper (cytoplasm), investigation discloses the presence of a differentiated area called the nucleus, which is a characteristic of every cell. Modern theories of heredity are theories of the cell-nucleus. The latter was first discovered in 1833 by Robert Brown in plant cells, but the signal rôle that it plays in the economy of the cell was not grasped till long afterwards. Thus phenomena of protozoan regeneration show it to be the preponderating formative centre, as such it is almost necessarily the chief chemical centre in the

cell. Indeed, we are compelled to think of a ceaseless interchange, a sort of whirlpool effect, as continually going on between nucleus and cytoplasm. Typically spherical, the nucleus may assume a variety of shapes: typically single, it may be double as in some liver cells, triple or quadruple as in some Ciliata, or even multiplied a hundredfold—as sometimes in the giant cells of bone marrow. It also occurs in all degrees of organisation.

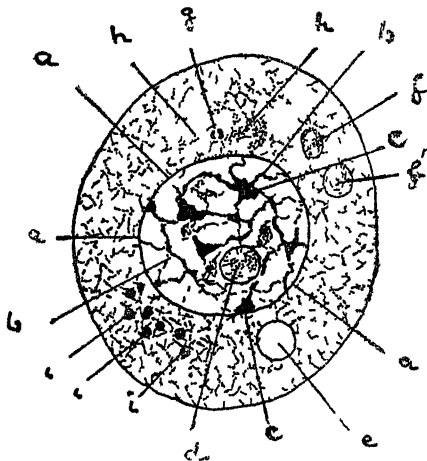


FIG. 2 — SEMI-DIAGRAMMATIC REPRESENTATION OF A CELL — (a) Nuclear membrane, (b) linin reticulum, (c) chromatin masses contained in envelopes of linin (chromatin nucleoh), (d) true nucleolus, (e) vacuole, (f) plastids, (g) centrosomes, (h) archoplasm from which attraction-sphere astral rays, etc. are developed, (i) food particles (From Walker's *Essentials of Cytology*, by kind permission of the publishers)

In any ordinary nucleus, the following structural elements may commonly be recognised

(α) The nuclear membrane, which is probably a concentration or felting of the original reticulum, thus permitting of direct communication between, if not direct continuity of, the intra- and extra-nuclear filaments

(β) The nuclear reticulum, which is composed of two distinct substances—chromatin and linin (achro-

matin). The former is ordinarily confined to the nucleus, where it is generally seen as irregular, deeply staining granules and masses, deposited upon the threads of linin, sometimes irregularly, at other times with such regularity that the meshwork seems entirely composed of them. The linin framework, however, should not be considered as an absolutely stable or rigid feature of a living nucleus, for it is liable to movement and change. In structure it also is apparently granular, and very similar to the cytoplasmic reticulum. Chromatin, which contains a high percentage of phosphorus and is a protein of great molecular complexity, is used up in all functional activity, but is as constantly renewed, it is indispensable to life, and the granules even move along the linin filaments towards the locality of need. Bernard has demonstrated the migration of chromatin outward towards the peripheral nerve endings in the retina, in connection with processes involving not merely the expenditure of the chromatin but also its creation. The quantity of chromatin in a nucleus is not constant, for the granules are capable of assimilation, growth, and division. In the processes connected with cell division and fertilisation they aggregate into little rod-like bodies known as chromosomes, and the longitudinal division of a chromosome involves the actual splitting of its component granules. The number of chromosomes is constant for each species,¹ and they are now commonly regarded as the vehicles of inheritance.

The well-established fact that chromatin granules exhibit the leading characteristics of living things—permanence and continuity of existence, expressed in specific behaviour, and yet maintained through constant change and lability of substance—at once raises the question as to whether they represent to us in any way the ultimate units of life. And the answer must be Yes and No. Yes, in the sense that such a chromatin granule, perhaps associated with short filaments radiating from its core, supported and extended by a unit mass of nucleoplasm,² affords us a theoretic unit capable

¹ e.g. man 48, mouse and lily 24, etc.

² Bernard, *op cit* p 10

of growth and division in its particular environment—incapable, however, of an extra-vital existence. It is, however, possible that there may be free-living organisms on this comparatively simple level of organisation amongst the problematic class known as the Chlamydozoa¹. No, in the double sense that on the one hand we can hardly suppose that the ultimate units of living matter happen to coincide with the revelations of the most powerful microscope of the twentieth century, and that we can imagine units simpler even than the Chlamydozoa. What is important to note is the primary and dominant rôle of the chromatin element as opposed to the purely cytoplasmic element in a cell. This probably represents the line of evolution². The enucleated cell cannot reproduce in the absence of nuclear material; all synthetic metabolism is at an end. Strictly, therefore, such a cell is not living, although for a short time any small portion of it may even still show characteristics of life, *eg* irritability, and other destructive aspects of metabolism. On the other hand, the fragments of a unicellular organism that contain the nucleus or a part of the nucleus can re-acquire the specific form in time.

Many other data, including study of the types of Protozoa with a so-called distributed nucleus, where in some cases an actual clustering is noticeable at a certain stage, also suggest such a precellular unit, termed by Bernard the chromidial unit, by the continued division of which with the later concentration and differentiation of the various massed elements, the typical cell may have been ultimately formed³. This points to the true cell as being "primarily a continuous linin-chromatic network with a differentiated centre which is a storehouse for chromatin, the whole being embedded in an

¹ Cf E A Minchin, "The Evolution of the Cell" (*Brit Assoc Report*, 1915, pp 454, 455) and *An Introduction to the Study of the Protozoa*, pp 470-474.

² Cf E A Minchin, "The earliest living beings were minute possibly ultra-microscopic particles which were of the nature of chromatin" ("The Evolution of the Cell," *op cit* p 454).

³ Cf *eg* H M Bernard, "Studies in Retina," *Q J M S*, vols 43-47.

albuminous semi-fluid matrix" ¹ The concentration of chromatin in the matted tangle of the nucleus with the corresponding felting of the filaments would lead to greater efficiency and co-ordination in response to the environmental stimuli, increased facility in the dispatch and localisation of chromatin at points where expendi-

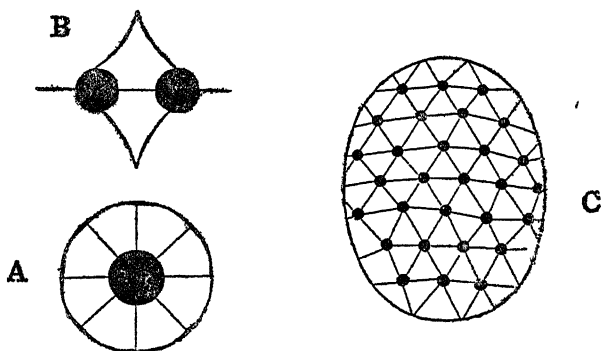


FIG 3

- A** The chromidial unit as a mass of chromatin with linn threads, which are at the same time nervous, contractile, and synthetic. The waste matters of its chemical reactions, carried out from the central mass along the linn threads are deposited as a pellicle at the surface of the fluid mass in which the whole is embedded. The tips of the linn filaments project slightly beyond the pellicle as nerves.
- B** Diagram illustrating the division of the unit, the linn threads in or near the plane of division split longitudinally, while those in or near the plane joining the centres of the daughter units simply lengthen out.
- C** An optical section of the three-dimensional network which would result from repeated incomplete divisions of such a chromidial unit, the chromatin masses divide completely, but the linn threads, though they lengthen and split, are never ruptured.
(From H. M. Bernard's *Some Neglected Factors in Evolution*.)

ture of energy was demanded, and the opening up of possibilities of differentiation in the filaments as nervous and muscular elements such as could not be obtained in a simple continuum of chromidial units. The chromatin is associated with the energy transformations and may be thought of as the seat of chemical activity the

¹ Bernard, *op cit* p 32

linin filaments are primitively contractile, nervous and synthetic in function, and would regionally become increasingly differentiated along these lines. Thus cilia find a sufficient explanation as terminal extensions of the originally uniformly distributed linin-chromatin network, while even the organisation of by-products like protozoan shells suggests by their radial structure an intimate connection with the linin filaments in their synthetic activity.

Finally, the demonstration of intracellular units of a lower order has an interesting bearing upon biological theory. Altmann's granular theory of the constitution of protoplasm, ill-founded as it apparently was in relation to his own investigations, regarded protoplasm as a colony of more elementary, extremely minute units which he called bioblasts. In a real measure these chromidia (chromatin granules), evidencing assimilation, growth, and division, correspond to Altmann's theoretical units with this immense advantage that in the linin filaments they have a means of communication with one another. They invite consideration as more elementary individuals than the cell, standing between the latter and the ultimate molecule of living matter. Herbert Spencer's "physiological units," Darwin's "gemmules," and Weismann's "biophors," all hitherto hypothetical units, playing the principal part in the theories of regeneration, development, and heredity associated with these great names, would thus appear to correspond to a reality.

(γ) The nucleoli, rounded irregular bodies composed of a protein substance markedly different from chromatin. They are, however, very varied both in structure and character, and in some instances, at any rate, are possibly a source of chromatin supply for the nucleus.¹

(δ) The nuclear sap or ground substance occupying the interstices of the network, and apparently unaffected by many of the stains that act on the chromatin. It is clear, highly refractive, and essentially liquid. Its functions in relation to the maintenance of turgescence and as a support to the linin-chromatin network, quite

¹ The typical nucleolus, however, of a tissue-cell does not stain

apart from all questions of chemical interchange, are highly important

A third element of the cell is the peculiar little centrosome first definitely discovered by van Beneden in 1885, which as the special organ of cell division is often regarded as the dynamic centre of the cell. It commonly lies outside the nucleus, although close to it, sometimes, however, inside (*Ascaris univalens*). It may be surrounded either by a radiating area of the cyto-reticulum, termed the attraction sphere or centrosphere, or by an area of protoplasm denser than the rest of the cytoplasm (archoplasm). Sometimes in the vegetative stage it lies unattended by any differentiated matter, and is then often very difficult to demonstrate. Typically the centrosome, which stains deeply and resembles a chromatin granule, is a single organ, but as a rule dividing cells show a double centrosome due to anticipation of the succeeding division in which each of the daughter cells receives one of them. The failure to substantiate its presence in the case of the cells of many of the higher plants, and the fact that in some instances at the close of cell division, or during fertilisation in animals, it disappears entirely to appear again *de novo*, rather militate against the earlier view of its indispensable and dominant function as an organ, although as a *locus* of specific chemical stimulation something undoubtedly exists. At the same time in the majority of cases as an organ that assimilates, grows, divides, and is in many cases passed on from cell to cell, it also answers to the conception of an intracellular unit of independent existence. It is essentially a centre of determining activity, and it seems finally to disappear with the loss of the power of reproduction.

With regard to the cell wall or membrane, we now know, unlike the earliest observers, that its importance is secondary. It is more characteristic of plant than of animal tissues. In the former case it has a more or less firm consistency, and is often of considerable thickness. On the other hand, many animal cells, *e.g.* rhizopods and leucocytes, are "naked," although even here some difference in consistency can be established.

between the outermost layer of the cytoplasm and that immediately beneath it. Where a definite membrane or skeletal structure occurs, it may arise either as a secretion product, probably in direct association with the linin filaments of the network along which the transformed substances pass, or as a direct physical and chemical transformation of the peripheral layer of the cytoplasm, also under the influence of the original chromatin-linin network.

Hitherto we have regarded the cell as an independent organism, as an organic unit, but it becomes increasingly difficult to maintain any thoroughgoing cell doctrine. The reproduction of *Amœba* through chromidial fragmentation and conjugation of the units raises the problem of the One and the Many in a bewildering fashion, and puts limits to the description of that and other types as unicellular forms. Actually the cell can only be considered as an independent organism in the case of unicellular organisms and the germ-cells of multicellular forms. When we consider other cells, *eg* the tissue-cells of the higher creatures, we see that in point of origin and structure, *ie* morphologically, they are equivalent to a collection of unicellular organisms, but physiologically the tissue-cell can hardly be regarded as independent, inasmuch as its activity is part and parcel of that of the organism—"its autonomy," to use Wilson's phrase, "is merged in a greater or less degree into the general life of the organism"¹. No true conception of the life of a multicellular organism is accordingly gained except in so far as that life is conceived of as a whole, untrammelled by cell boundaries. Doubtless it expresses itself in many ways, particularly in the form of the cell, thereby giving to itself an apparently composite character. But in reality this mosaic-like character is due to the secondary distribution of the organism's energy among local centres of action. This distribution follows the lines of linin-filamentous connection between the cells of any multicellular organism, and delicate intercellular bridges of protoplasm are demonstrable in many cases between the individual cells of plant and animal tissue.

¹ E B Wilson, *The Cell in Development and Inheritance*, p 58,

The problem of the co-ordination of the individual cells' activities is very much the problem of the cell and its enzymes repeated on a larger scale. There, as we shall see, the question is how the cell links together, and co-ordinates the activities of various substances within it, each of them with its specific function. In the higher animals and plants the different tissues retain in varying capacities vestiges of the primitive power of altering their function under normal conditions they behave according to their specific character. But evidently there is some restraining influence that limits and regulates the activity of any particular cell, or group of cells, in relation to the other cells of the organism.

4. A further characteristic of living things is irritability, by which is understood the capacity for response or reaction to stimulus. Life, in fact, resolves itself into the science of response—response to various external and internal stimuli—simple at first in the case of the lower forms, but infinitely complex in the higher forms, embracing in the last instance all that is implied in the word "education." The unresponsive is the dead, that peculiar condition in which the capacity for response is gone.

Now, in all applications of stimuli to living matter, what we see, as a direct consequence, is a series of very complex phenomena due to the fact that these stimuli have affected an exceedingly complex object in the organism upon which they act. When these phenomena of irritability, as exemplified, say, in a protozoon, are analysed, we find a series of specific capacities for response which have been styled tactisms. *Paramecium* is sensitive to light in that it moves towards it, it is therefore positively phototactic. Irritability, then, usually expresses itself in some form of movement of the organic mass—some readjustment in the equilibrium of its matter and energy—which has often led to this feature being set down as a characteristic of living matter, but while every response need not necessarily be in the form of obvious movement—the energy liberated may take some other form, *e.g.* heat, or light as in the case of the firefly—on the other hand, in many

cases of apparently spontaneous movement, the cause is to be found in internal changes rather than in the external environment. It is essentially a liberation of energy—the transformation of potential into kinetic energy, and this commonly shows itself in movement. Such movement is generally found to conduce to the well-being of the organism. Irritability, in short, is the physical aspect of organic adaptability in the lower forms of life especially.

The expression of this irritability was almost certainly originally associated with the limn elements in the protoplasmic reticulum. For irritability is as marked in protozoon and sponge as in the higher forms of life, and the only structure through which a response could be given in default of anything comparable to a nervous system is the limn reticulum, which is contractile and capable of transferring stimuli—a primitive undifferentiated nervous tract. That this original network underwent differentiation in connection with other elementary functions¹ did not hinder certain portions and tracts developing as a nervous system in complexity proportionate to that of the organism as a whole. Such specialisation of tissue for other functions would necessarily involve the inhibition and decline of the original elementarily nervous character of the reticulum in these regions.

In the case of the higher animals and plants, the distinctive elements of irritability, studied singly as tactisms in the case of unicellular forms, may function in a specific way in the parts of a multicellular organism, giving rise to movements known as tropisms. Thus a characteristic turning towards the sun gives its name to the flower heliotrope. It has been suggested that many movements of animals and attitudes of plants depend upon mechanisms that are “a function of the symmetrical structure and symmetrical distribution of irritability on the surface of the body of the organisms.”² This involves the assumption that symmetrical points

¹ For the detailed proof of this statement, reference should be made to Bernard, *op. cit.*, chap. xi.

² J. Loeb, *The Dynamics of Living Matter*, p. 5.

on the surface of an animal possess corresponding degrees of irritability. If, then, lines of force (*e.g.* light rays, gravitation lines, lines of diffusion) strike an organism with greater profusion on one side than on another, the tension of the contractile elements is unequal, and if the animal moves, it will tend to turn in such a direction that the lines of force impinge with equal density at symmetrical points, and at the same angle on both sides, and it will continue to move in that direction, or away from it, according as it is apparently attracted or repelled. Such automatic orientation in a field of force toward or away from the centre of force constitutes the so-called tropism. That is to say, it is not curiosity, or love of light, that makes the moth fly to the candle flame, but the compelling power of the light in turning the creature's head towards it. This line of interpretation, however, has been shown to be insufficient in the case of humbler forms,¹ and is probably not less so here.

The external stimuli which act upon the world of life are manifold, being thermal, luminous, chemical, etc., in character. The reaction of an organism is, then, simply its response to the particular stimulus applied to it. The experience of everyday life is sufficient to show us that under the same stimulus that reaction will vary considerably with different individuals. In fact, the same stimulus may produce totally different effects on differently constituted objects. A kick elicits a different response in the case of a stone, a bulldog, and a Skye terrier. Under electrical stimulation the salivary gland yields its saliva, the liver its bile. On the other hand, it is not so obvious at first sight that very different stimuli may produce identical effects upon the same protoplasmic body. Yet apply to a muscle cell electrical, chemical, in short, any possible form of stimulus—it has but one answer—it contracts. The same was supposed to hold good for some Protozoa, but closer study has shown a measure of indetermination and freedom in the protozoan response.² We have thought of the

¹ Cf. pp. 253, 254.

² H. S. Jennings, *Behaviour of the Lower Organisms*.

stimulus as exciting or even producing an increase of the specific activity in various forms of living substance its action may, however, also result in a diminution of that characteristic activity. Irritability is considered to be a fundamental property of living protoplasm, but it expresses itself in specific actions, according to the specific structure of the organism, under the influence of the external world.

With this fundamental property of irritability, of which certain other properties of protoplasm are ultimately but different specific expressions, may be considered the characteristic of insusceptibility in varying degrees, or functional inertia—to use the term proposed by Harris¹. By this is meant not merely the relationships of living matter to stimuli in which it shows no response, but also those states in which it continues to respond specifically after the stimulus has ceased to act, or an inhibitory stimulus has been applied. Life is not in tissue, organ, organism, or even society a continuous march, due to everlasting response to unceasing stimuli, such as it would be if irritability alone were characteristic of living things. We are aware of limits of stimulation, of calculable pauses till the effect of the stimulus is seen, of a not uncommon lack of correspondence between stimuli and responses, of certain protoplasmic activities apparently spontaneous and automatic in their persistence under conditions that united almost tend to suppress them. Thus, in a sense, at any moment the expression of an organism's life is the resultant of these antagonistic properties of irritability and functional inertia which are present in varying and characteristic degrees. The presence of this biological inertia lies rather in non-correspondence with the environment of impinging stimuli.

Of the various phenomena expressive of this inertia those that illustrate a "latent period" between the application of a stimulus and the appearance of the resulting response are the most general and the best adapted to demonstration. They are observable in the Protozoa, characteristic of muscle, nerve, and other

¹ D. F. HARRIS, *The Functional Inertia of Living Matter*

tissue in higher forms, and are peculiarly striking in certain vegetable protoplasmic reactions. This "physiological lost time" permits of definite calculation, giving thus in some degree a measurement of the inertia. In those cases where specific action persists after cessation of the stimulus, and even in local post-mortem growth, we have phenomena comparable to the continued swinging of a gate after a push, which point to a functional inertia in living matter. When we widen our range and consider individual and racial characteristics, we may see in heredity the broadest expression of this functional inertia, displaying itself in physical and psychical realms alike. Habit and instinct owe their existence to such inertia, in it are some mainsprings of character. How far this characteristic of living organisms is directly connected with any similar property of the ultimate molecules of living matter is a question upon which as yet we have not sufficient data to come to a certain conclusion. When confined to the physical aspects of protoplasm we have an explanation that is within the range of probability. But to state in particular, as Harris does,¹ that "mind has inertia because cerebral protoplasm has inertia, and cerebral protoplasm has inertia in common with the lowliest fraction of living matter" is to offer an explanation in terms of a causal relation between matter and mind that is not warranted by the facts at our command.

¹ *Op cit* p 86

CHAPTER IV

PRINCIPLES OF BIOLOGY (*continued*)

5 ALL living things are further characterised by continual change, physical and chemical, of the material composing the body in every part. Certain parts are being continually used up, and fresh material is brought in and built up into its place. This ceaseless internal cycle of supply and waste, waste and supply, is designated by the term, metabolism. In metabolism there are three principal stages—Absorption (of new material), Transformation (in the interior of the protoplasm) leading to Retention of synthesised matter, and Excretion of waste. Protoplasm is found capable of absorbing or excreting matter either in a gaseous, fluid, or solid condition. The living organism is as a flame that, fed with oil, preserves its outward form, yet all the while the substance by which the flame is fed is being decomposed into its constituent elements and passes off transformed. Biology, apart from Morphology, knows no statics. Nutrition and digestion, respiration and circulation, secretion and excretion, are various phases of this comprehensive activity. Continually in the living cell substances of complex molecular—and in that measure unstable—structure are being built up from substances less complex and more stable, with the absorption of energy. Concurrently, other substances rich in potential energy—food reserves, or the protoplasm itself—are being broken down in order to provide the energy required. The more intense the life, the more comprehensive are those parallel processes of construction and destruction¹. And yet if parallel, they are hardly equal. In the period of youth the constructive

¹ Or, more technically, anabolism and catabolism

is in excess of the destructive, and we say the organism grows

'Now, all living things grow in a sense that is not predicable of other objects to which the word may be applied. For in the saturated solution of salt or alum the crystal grows by accretion—particles are added on the outside, layer by layer. Living things grow by taking up particles of matter in between already existing particles at every point—interstitial growth. Further, the crystal grows by adding to itself particles of the same matter as itself—particles that it takes up, already existing, out of the fluid around it, whereas the living thing makes the materials of its growth, manufacturing particles like itself out of material different from itself, which it then uses for growth—by assimilation. The ciliate protozoon, *Paramœcium caudatum*, if kept in a hay infusion at a definite temperature, will grow and reproduce by binary fission at a definite rate. This growth and reproduction are accomplished at the expense of elements in the medium which are transformed into *Paramœcium* at the same time other substances appear in the medium which are the waste from the growth process. If we call these last b , and let a represent the material that goes to form new *Paramœcium*, then $P+a=nP+b$. This growth formula may be instructively compared with that of any purely chemical equation, with the result that a striking difference is noticeable. In the case of an effective chemical reaction between different compounds, the result will be found to be of the general character $A+B=C+D$, i.e. different substances are found in the two terms (e.g. $\text{Zn}+\text{H}_2\text{SO}_4=\text{ZnSO}_4+\text{H}_2$).¹ In the former equation the fact that P appears on either side constitutes a veiled expression of a characteristic of life—that it occurs in a greatly increased quantity indicates the amount of growth. As a matter of fact, however, this formula represents but half of what is actually in progress, for at the same time other processes

¹ This statement excludes the phenomena of catalysis between which and some aspects of metabolism a certain measure of analogy may be traced. Cf. pp. 74, 75

of a contrary or destructive character are in operation, and the organism is alive only so long as they do not gain the ascendancy over the assimilative activities

From the work of destruction, which may involve the breaking up of complex substances into simpler ones, or their combination with oxygen, various final products arise, some useful to the organism, *e.g.* bile, others not so useful, or positively harmful, as urea, carbon dioxide, and mineral salts. In the case of animals the whole of their energy is derived from waste, in plants only a small part is thus derived, the rest being obtained from sunlight. The metabolic processes that are going on in any higher organism, plant or animal, are manifold in the extreme, and even in the case of unicellular forms our understanding of them is far from complete. At the same time the unity of the entire organic kingdom is well illustrated in a restricted series of fundamental metabolic processes which are common to every living thing.

(a) Every plant and animal respire, *i.e.* it takes up oxygen from its environment, whereby it oxidises the carbo-hydrates and albuminous substances of its own body, producing as final products carbon dioxide and water. Oxidation in living matter is however a much more complicated process than the simple chemical activity ordinarily expressed by the term. There is much in it that is physical as well.

(b) The food materials of all living organisms, plant and animal alike, are originally prepared from the inorganic world through the instrumentality of chloroplasts, whose contained chlorophyll (leaf-green) has the power of arresting and transforming part of the energy of sunlight. Further, while it is true that growing plants are able to live on simpler compounds than animals, yet a study of the development of the embryo in the seed¹ shows it to be without the adult capacity, and dependent on manufactured carbo-hydrates, proteins, and fats, as in the case of animals. The differences relating to the mode of supply in the case of the two kingdoms are ultimately referable to differences in the

¹ The same also holds true of growing cells in a young stem or root

cell structure The exaggerated development of the vegetable cell-wall prevents the ingestion of solid material

(c) In both animal and vegetable kingdoms, characteristic, and in some instances corresponding, substances make their appearance during metabolism, and play a very important regulative part, not merely in the constructive process but also in the breaking up of reserves and in excretion These substances, *eg* diastase in plants and ptyalin in saliva,¹ are known as enzymes² and are marked by very distinctive features Thus, in the course of their activities they undergo no change in themselves They do work out of all proportion to their quantity, without leaving a trace of their own substance in the products of their activity Such characters invite comparison with the catalytic substances of pure chemistry, but the differences are no less marked So fundamental is the action of these enzymes that there is a very true, if limited sense, in which it may be said that life is the enzyme (first degree) of enzymes (second degree) The evidence goes to show that some kind of enzyme is at the basis of every functional activity Digestion is due in part to the action of pepsin which breaks up proteins Respiration is only achieved through the presence of oxidase, which seizes the oxygen in the lungs, and hands it over to the red corpuscles of the blood Under certain conditions—commonly greater concentration of the solution—the action of some enzymes is reversible, *ie* they can put together again what they have taken apart, and there are others that devote themselves solely to this aspect of the matter³ What the enzyme is in its inner nature

¹ The function of both of these is in general terms to change starch into sugar

² Mention should also be made of vitamins, of whose chemical structure and mode of action comparatively little is as yet known

³ It is, however, easily possible to misinterpret the significance of this reversibility "In spite of what is known as reversibility of enzyme action, the law holds universally that an enzyme can never use energy derived from one reaction to run another in which building up of energy occurs, while in the living cell this is done in a thousand forms in which myriads of synthesised products are built up An enzyme always runs a downhill reaction, and when it is apparently

or how it is produced is still unknown. Mostly soluble in water or some other medium, and colloidal in character, they prove but slightly resistant to heat. Possibly they are morphologically comparable to units of the chromidial or even pre-chromidial days, just as in the human body we find survivals of the unicellular period in the leucocytes of the blood. Investigation into their nature proceeds apace, and marvellous success has been achieved in some instances in separating and instigating them to work apart from the living environment (*e.g.* pepsin) others prove as yet to be inseparable from the living protoplasm.

It should, however, be remembered that no account of enzyme-action, however complete, helps our ultimate account of life, since it gives us no clue to the characteristic achievement of the cell in connecting, co-ordinating, and regulating these various activities that take place within it. Not merely is the enzyme an organic production, of which there are sometimes several types at work in the economy of a single cell, but, unlike the ordinary catalyser, each enzyme is usually only able to act in its specific way upon one definite type of molecular arrangement, while the cell as an energy transformer is distinguished by the way in which it connects the varied complex reactions effected by these enzymes which it has itself produced. Accordingly, to consider the cell activity as simply the sum of varied enzyme activities, is to make the same mistake as to suppose that an organism is the sum of its organs. It is to offer only a partial account of cell life. If regard were had merely to the action of the enzymes, the interpretation *e.g.* in the case of plant life, would be mainly catabolic, for there is as yet no enzymic account of the actual building up of compounds with higher chemical potential, which is so distinctive a feature of life. The study of enzymes is the study of isolated, yet highly selective activities, each enzyme must fit its substratum like lock and key

reversed this really only means that the concentrations requisite for reversal are such that (chiefly due to osmotic pressure variations) the reversed reaction now runs downhill"—(B. Moore, *Biochemistry*, p. 19)

or the reaction does not occur. But the characteristic of the living cell is seen not merely in the connecting of one reaction with another, and in the using of the free energy of one reaction to carry on another, but also in the actual production of new enzymes to cope with new situations¹. The cell initiates, directs, and co-ordinates the enzymic activities, but in the more difficult cases of metabolic change, as in the conversion of carbo-hydrates into fats, or of CO_2 and H_2O into organic compounds, energy is taken up from other sources, and this the cell alone can do. "This is the part taken by the living cell, which in one oxidising action obtains free energy, and in an accompanying reducing action stores this energy up, at least in part, in a new synthesised body at a higher potential of chemical energy than that from which it came. In this process enzymes may freely be used by the cell, but they are co-ordinated and regulated in the process"². All this fundamental metabolic activity, then, is in some way controlled for the good of the individual, and in this directed control we have a distinctive character of life. And in particular aspects of it, *e.g.* the maintenance of body temperature in warm-blooded vertebrates, or the transfusion of materials through cell membranes, there is a regulation of process in the living form that is distinctive in the sense that it does not entirely conform to physical practice as known under purely inorganic conditions. The same general conclusion holds with regard to the part played by the internal secretions or hormones which, as the result of their distribution throughout the body by means of the circulatory system, act as chemical regulators of organic function, as also with regard to the activities of the nervous system as an instrument of organic co-ordination. The summed activities afford no explanation of that controlled adaptation of the whole in the interests of its well-being, which is the most noticeable feature about living things.

(d) As the result of these metabolic processes,

¹ F Czapek, *op cit* p 100

² B Moore, *Biochemistry*, p 244

corresponding products are organised in the plant and animal kingdoms, *e g* starch in plants and glycogen in animals, oxidases and trypsins in both ¹ Finally after metabolism is at an end, nothing is more remarkable in the "balance of Nature" than the part played by bacteria in helping to restore to the inorganic world the complex chemical compounds which would otherwise remain locked up in the tissues of dead plants and animals

The differences between the multicellular animals (Metazoa) and plants (Metaphyta) are based on broad lines, physiological rather than morphological. Animal and plant alike in virtue of their cell structure are composed of that fundamental linen-chromatic network whose functions are synthetic, contractile, and nervous. In the case of plants the synthetic function has dominated the other two in consequence of the unique way in which they obtain their food, in fact, the primitive contractile and nervous functions of the plant reticulum have shown no advance. As a result all the organic substance in the world is ultimately created by plants by means of the radiant energy of sunlight. Animals, so far from creating, are continually destroying organic matter and resolving it again into its original components, in this sense they are essentially destructive, while green plants, on the other hand, are both constructive and destructive. The food of plants exists in a gaseous state in the atmosphere, or as salts in solution in water. It requires therefore no preparation, and can be directly absorbed by the surface of the roots and leaves. The method of feeding is almost strictly chemical. But the food of animals, being organic matter, is usually in a more or less solid condition, which necessitates the presence of an internal reservoir in which the food can be stored until it is reduced to a more or less liquid absorbable condition. That is to say, almost all animals require a stomach, implying the development of muscle and nerve, and in the case of the

¹ For details of these processes reference may be made to any biological textbook, *e g* L. L. Woodruff, *Foundations of Biology*, A. Dendy, *Outlines of Evolutionary Biology*

Protozoa the whole creature functions as such for the time being

Again, the food of plants is everywhere present Every wind that blows brings food to the leaves rain-water with salts in solution bathes the roots Their food-taking is essentially passive Animals have to seek their food, it does not usually come to them Hence the nature of animal food requires that they shall have a definite mouth, a digestive tract, organs to carry the body in search of food, organs to seize it when found, and definite excretory organs to get rid of the waste Free locomotion in the case of plants, apart from the Protophyta, is confined temporarily to the male cells, and with the absence of movement the function of sensation is at a minimum Plants and animals thus differ in the nature of their food, yet both are dependent on the environment for supply, and that food when elaborated into "the physical basis of life" by contact with the living body, shows little fundamental chemical difference as animal or vegetable protoplasm

6 All living things exhibit cyclical phases of activity known collectively as a life-history, in which they manifest various degrees of vitality, sometimes with accompanying change of form Every living creature, unicellular and multicellular alike, passes through a regular cycle of changes, in part determined by forces within itself, to which there is nothing comparable in the inorganic realm Indeed, the extraordinary changes in the individual should make it easy to believe in change in species Such change is the mode of Nature

Reference has been made to a period of youth characterised in both cases by active cell-proliferation the constructive (anabolic) phase of metabolism is then in excess of the destructive (catabolic), and the creature grows This is followed by a period of adolescence in which, although at first the two phases practically balance, yet the energy of division sooner or later diminishes, and is accompanied by certain changes in cells previous to fertilisation—that process whereby the energy for division is renewed This in turn is

succeeded by the period of old age in which destruction slowly overtakes construction, and eventually the organism dies. The unicellular organism may also die from protoplasmic senile degeneration as does the multicellular form. Now, this "capacity for death" is in a sense a distinguishing feature of living things. In a very real way, moreover, death is the servant of life, holding the balance between unlimited reproduction and limited feeding area. To it is due the circumstance that life is periodic in appearance—the recurrence of the living individual is a phenomenon unique in the realm of Nature. This intermittent character of life is, however, seeming only. The death of the individual that has reproduced by means of a germ cell detached from the body cells involves no break in that series of continuous cell divisions which thus extends backwards to the dawn of life.

To this cyclical movement there have been supposed exceptions. L. L. Woodruff,¹ *eg.*, has cultivated *Paramœcium caudatum* through some ten thousand generations during a period of fourteen years, and considers that the varied culture medium with which these results have been obtained corresponds more accurately to the natural environment of the organism than the more constant media used by other experimenters which have usually proved favourable to conjugation. Considerations akin to these led Weismann long ago to speak of the "potential immortality" of unicellular forms,² meaning by this that natural death is unknown amongst them, being an incident connected with the transition to multicellular forms. Whatever may ultimately prove to be the scientific truth underlying the conception—and certainly the conditions of protozoan life are much more complex than has been ordinarily supposed—it is obvious that the term "immortality" is a misnomer in this connection. Etymology even would indicate that immortality could alone be postulated of the *in*-dividual, whereas the Protozoa

¹ *Archiv für Protistenkunde*, vol. xxi p. 263, *Foundations of Biology*, p. 246

² Cf. *The Evolution Theory*, vol. 1 p. 260

are essentially dividuals, lacking that *m*-dividuality without which in its most developed state immortality is inconceivable. If the Protozoa were really immortal there could have been no evolutionary progress, and the waters would ere long have been choked up with them¹. If death had not dogged the footsteps of life from the beginning, the Protozoa would have used up all the assimilable material, and no higher form could have come into existence by that way. Mortality is an essential prerequisite of immortality. In some cases of parthenogenesis a process of continuous growth is apparently strictly followed throughout the history of the species, but again there is always, ultimately, death of the individual. In some of the higher plants and trees, construction seems to be continually in excess of destruction, and the tree may be said to grow as long as it lives. The plant is much less a "closed system" than an animal. Nevertheless, the individual eventually dies, even although, *e g* by grafting, perpetuation of the race may be secured without fertilisation.

Further, we may remark that not merely during those internal changes of every part that comprise metabolism, but in those changes of the whole that are involved in the conception of its life-history, the living organism maintains a certain individuality and integrity. In spite of the constant metabolic change, in spite of growth and decay, the living organism possesses a more or less constant form which serves as the arena in which those changes are displayed. Thus, if from the combined points of view of irritability and metabolism, we think of the living organism as in a condition of continual specific change, its activity at any moment may be symbolically expressed by the formula $A \times B$, where A represents the first of a series of states ($A_1 A_2 A_3 \dots$) of the organism, conditioned by successive states of the changing environment ($B_1 B_2 B_3 \dots$). That is to say, any specific activity at any moment is to

¹ It is calculated that one of the rod-like bacteria less than $\frac{1}{1000}$ inch in length multiplies in natural conditions at a rate which, unchecked, would within five days fill all the ocean to a depth of one mile with its progeny.

be considered as the resultant of two factors, its state at the moment under consideration and the aggregate of environmental stimuli or circumstances. This activity in turn creates a new state (A_1) defined by what A was and what the reaction ($A \times B$) has been, which in like manner is modified by the changing environment (B_1) into a new activity (A_2). Now, in the case of the organism something remains all through—a specific type—expressed by A , A_1 , A_2 , etc. In short, we are aware of the maintenance of a state of dynamic equivalence between the organism and its environment which has, strictly, no parallel in the inorganic realm, and which within the organic kingdom increases in complexity the higher we rise in the scale of life. Continuously the organism is alive, and yet its material identity does not depend upon identity of matter. The matter changes, but the form remains more or less constant, the individuality usually even more so. These forms with their similarities and dissimilarities serve as the basis of classification. The fact that life shows itself always in some specific form would appear to negative completely the possibility of any merely chemical interpretation. This would involve an ultimate explanation of organic forms in terms of the arrangements of atoms and molecules. A leucocyte certainly has a chemical composition, but the fullest description of that chemical constitution will never give any necessary explanation of its form, still less of that of the organism whose vascular system it patrols. Life is something more than the raw materials it employs. We may speak of life in general, but we never know it except as the special phenomena of a particular organism. Life clearly has unity or individuality at the core of its meaning, and in the scheme of Nature, one of whose dominant features is a tendency towards higher individuation, the supreme example is found in man, with his characteristic awareness of individuality, and the possibilities involved in its complete attainment.¹

7 All living things are *capable of reproduction*

¹ For a fuller development of these statements, reference may be made to *Man and the Attainment of Immortality*, chap. ix.

Having a definite term of existence, they must reproduce themselves, otherwise the organic kingdom would soon pass out of existence. The individual dies—life is intermittent in form—not, however, before having, in most cases, by a kind of discontinuous growth, given rise to forms more or less like itself, which in their turn grow and reproduce their kind. No non-living thing reproduces itself exactly in this way.

(a) *Division* The simplest form of reproduction is by division. The need for this arises in part through assimilation—a direct result of overgrowth. For the due interchanges (*e.g.* respiration) between a cell and its environment, a certain ratio is necessary between surface and bulk. But this ratio is disturbed by growth in the case of an organism that retains its shape, inasmuch as, while the bulk varies as the cube of the diameter, the surface grows but with the square. Further, as we have learned, the nucleus which is so intimately concerned with assimilation, is limited in the area of cytoplasm that it affects through the continual intercourse between the two. Accordingly the requisite surface is gained through the division of the mass, and the mother cell loses her identity in that of the two daughter cells. Such reproduction accordingly takes the form of discontinuous growth. Growth, then, is primarily assimilation, secondarily division—the multiplication of cells. Division is a result of that expansiveness which is the very symbol of life. As such it is the normal method of increase.

Typical cell division in unicellular and multicellular forms alike is a highly complicated though rapid process, involving the actual splitting of the chromatin granules through longitudinal division of the chromosomes.¹ In the case of the linin reticulum those filaments which lie in or near the plane of division are split longitudinally, while those that lie at right angles to this plane and connect the centres, as it were, of the future daughter

¹ This process of indirect nuclear division is usually called mitosis (Gr *mitos*, a thread) from the circumstance that the chromatin and linin elements first range themselves in a tangled skein which segments into the chromosomes (cf Figs 1 and 4)

cells simply lengthen and grow. This power of division, inherited from the precellular chromidial unit, we can only think of as a definite characteristic of life. As a result, every particle of the chromatin and, in great part, of the linn also, of the mother cell is equally divided between the re-organised nuclei of the daughter cells. At the same time it must be remembered that although the process of cell division admits of simple description,¹ yet of the actual mechanism or of the energy at work we know practically nothing. In the case of tissue formation and embryonic development such division of cells does not involve their absolute separation.

(b) *Fertilisation* Simple cell division, however, is only one aspect of reproduction. The culture study of Protozoa has shown that, with the possible exception of some extremely low organisms, there may come a time in the life-history of unicellular forms when, after a greater or less number of ordinary divisions, it appears as if the cells were becoming worn out, shrinking in size, and showing signs of nuclear degeneration, so that a prospect of final extinction looms in the future unless they are able to fuse together in pairs with cells of different origin, thus producing an elementary organism that becomes the starting-point for a new series of multiplications by division. This would seem to be a fact, although much recent research tends to make it doubtful as to whether conjugation, as such fusion of protozoan pairs of cells is termed, is so rhythmic a phenomenon as the older investigators believed. For them, the protozoan life-history resolved itself into a cycle, the starting-point being furnished by any two cells which, after fusion, either separated and divided, or commenced to divide as a single organism when fused, and continued so to multiply asexually, sometimes to the number of tens of thousands of individuals, till what has been described as senile degeneration set in. At this stage union of these cells with others of different origin was considered invariably necessary for the per-

¹Cf E. B. Wilson, *The Cell in Development and Inheritance*, chap. 11, or other standard works.

petuation of the species. It would certainly seem as if the protozoan cycle of simple binary fission may be greatly extended under definite environmental conditions, and the evidence for an internal nuclear reorganisation process (*endomixis*) in some cases, without the co-operation of a second cell, further proves the unwisdom of attempting generalisations on the manner of protozoan life-histories. Nevertheless, where it occurs, this process of cell union, of which, in those instances even where the organisms later separate, the fundamental characteristic is a reciprocal exchange and fusion of nuclear substance—an exchange of experiences—between the uniting or conjugating elements, illustrates the simplest type of that second aspect of cell reproduction known as fertilisation.

In the higher forms of life, instances of parthenogenesis apart, we have a similar process—fusion of cells of different origin, here, however, the fusing cells never separate, so that the element of exchange drops quite out of sight. The essential feature of fertilisation is the union of a nucleus of paternal origin with a nucleus of maternal origin to form the primary nucleus of the next generation. In multicellular organisms the cells which result from the division of the fertilised egg remain associated together, thus forming a complex colony of cells, an organic individual, however, of a higher order than the *Volvox* community. In a sense this multicellular organism is morphologically comparable with the sum of the cells produced by asexual division from the two unicellular ex-conjugates. The cycle closes in the higher forms when the sexual cells have become mature, and separate from the parent to unite in the process of fertilisation, which forms the starting-point for the new generation of dividing cells. All this is a very complicated process in the case of the Vertebrates and Invertebrates, but in the lower multicellular Algæ it is simple enough. The capacity which every cell, *e.g.* of *Pandorina*, exhibits of helping to reproduce the whole multicellular organism is not seen when the organism is somewhat more highly developed. For, in that case, the component cells sooner or later become differentiated

into two great classes, the members of which Weismann termed "somatic" and "germ cells" respectively. The former are of prime importance for the individual life, being differentiated into those various tissues which collectively form the "body". The germ cells, on the other hand, are of less significance for the individual life, but in eventually giving rise to new creatures are intimately concerned with the interests of the species. This differentiation is markedly noticeable so far down in the animal scale as *Volvox globator*. Amongst the very numerous cells that constitute a colonial form like *Volvox*, some remain vegetative and others are transformed into reproductive cells. At the same time it is right to bear in mind that the distinction, even in the case of the higher animals, is only relative, since both sets of cells ultimately have a common origin in the fertilised egg-cell, while many facts connected with regeneration and grafting are only interpretable on the supposition that germ plasma is not necessarily restricted to germ cells.

Further, a progressive differentiation not merely between the two kinds of germ cell which unite in fertilisation, but in the type of individuals producing them, is also noticeable. In the simplest forms the conjugating elements are exactly alike to all appearance, yet already amongst the Protozoa differentiation has been established, perhaps in the case of the *Paramœcium* conjugates, and certainly in their micronuclei. The eggs of the colonial *Volvox* are large, and fertilised by minute biflagellate sperms that are produced in dozens by the division of a mother sperm cell, in the case of the sporozoon *Coccidium schubergi* the differentiation of the gametes is even more striking. In the case of the higher animals we have eventually two types of organisation producing two types of reproductive cell, whose differing form and function have from the first betokened a physiological division of labour. The uniting cells must meet, this is ensured by the small, active, unencumbered sperm. A sufficient supply of nutrient material must be provided for the early stages of the developing life, this is supplied by the large, passive,

yolk-laden egg The organisations that produce these differing types of cell are ordinarily known as male and female respectively But this does not necessarily involve any particular maleness in the one case or femaleness in the other—the unfertilised eggs of bees develop into males In the organic world sperm and egg cells are derived from reproductive cells that initially are similar in size, appearance, and origin, but have become differentiated through developing in different directions

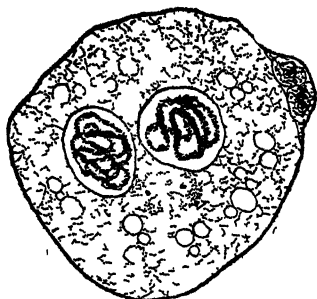


FIG 4—FERTILISED OVUM OF *ASCARIS*—Male and female germ-nuclei, with chromatin at continuous thread stage the centrosomes are separating To the right are the extruded polar bodies (From Walker's *Essentials of Cytology* by kind permission of the publishers)

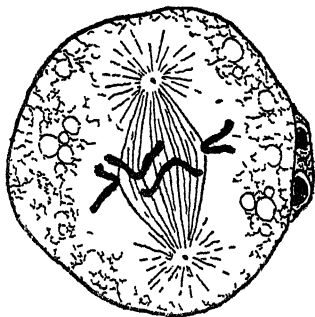


FIG 5—LATER STAGE IN FERTILISATION (*ASCARIS*)—The membranes of the germ-nuclei have disappeared, and the two chromosomes derived from each, four in all, have become attached to the spindle fibres (From Walker's *Essentials of Cytology* by kind permission of the publishers)

Indeed, all the adaptations and associations connoted by the words male and female are secondary to the essential fact of fertilisation, which is the same in higher and lower types alike, namely, the union of equivalent nuclei from different sources to this all other processes, and they are many, are tributary

While certain experiments seem to indicate that environmental influence may in some instances affect the sex ratio, it is probable that in the generality of cases the sex-determining factor must be sought elsewhere, and previous to the commencement of develop-

ment In the case of certain species of insects, man and other forms, it is connected in some way with what has been described as an "accessory" chromosome Demonstration has been made of insect species with two kinds of sperm—one with, the other without, the accessory chromosome Its presence is also indicated in the egg cells According as the fertilisation is effected by the first or second type of sperm is the resulting individual female or male Various types of the accessory chromosome or even chromosomes have, however, been described, and it must not be supposed that they "produce" sex in any sense, it is just as conceivable that they may be the result of sex-differentiation Sex is probably a resultant of many complex causes¹

Previous to fertilisation, a ripening process takes place in both spermatozoon and ovum, which is usually termed maturation As a result of it, every male cell produced in the course of the process is capable of functioning, though this is not the case with the female cells, of which only one in four are potential egg cells With maturation is intimately connected a reduction in the number of the chromosomes to one-half the number characteristic of the species in this way a progressive summation of the chromosomes throughout succeeding generations is prevented The procedure is complicated, but in the case of animals it appears that previous to the penultimate of the two final divisions by which the definitive germ cells are formed, the peculiar appearance of the chromosomes as thickened and sometimes loop-like bodies whose number is however only half that which is typical for the species, really represents in each case a temporary conjugation (synapsis) of homologous paternal and maternal chromosomes which have hitherto remained distinct in all the cells from the stage of the zygote onwards This is followed by a reducing (meiotic) division in which they separate, so reducing the number of chromosomes in each gamete to half that which is characteristic of the species, but

¹ Cf E G Conklin, *Heredity and Environment*, pp. 157-171, L Doncaster, *The Determination of Sex*

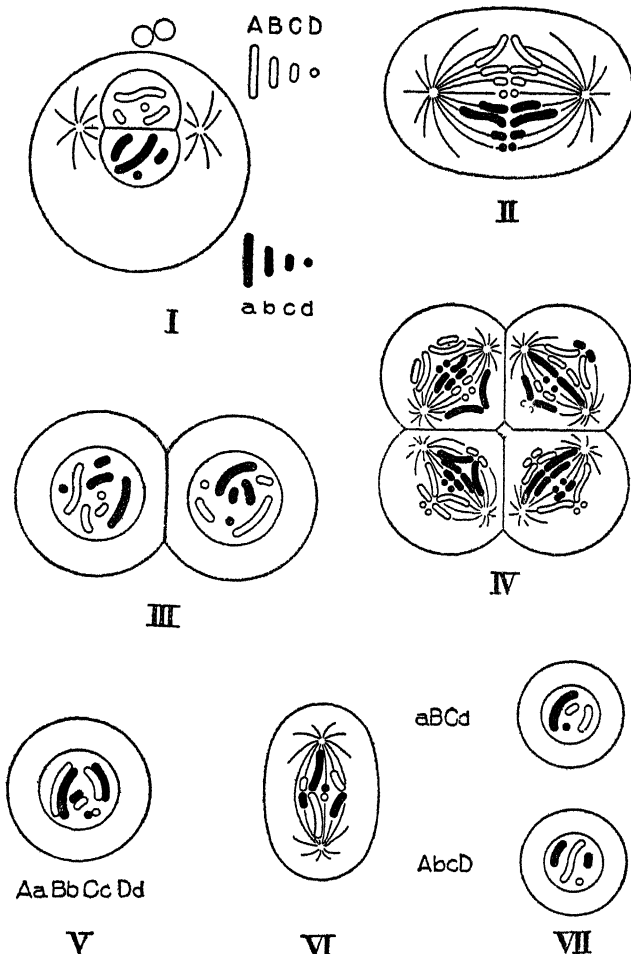


FIG 6—Diagram of the chromosome cycle of an animal. Somatic chromosome number assumed to be eight. Paternal chromosomes (from sperm)=*ABCD*, maternal (from egg)—*abcd*. I, union of nuclei of gametes, each with a simplex group (reduced or half number) of chromosomes, in the zygote at fertilisation to form a duplex group (full number) of chromosomes. II, III, IV somatic divisions of germ cells before mituation. V, synapsis, involving pairing of homologous paternal and maternal chromosomes to give the reduced number of paired chromosomes. VI reduction division—separation of pairs into single chromosomes. VII, two gametes with simplex groups of chromosomes, there are 16 more possible combinations of the chromosomes, or types of gametes, which are not shown. (After Wilson, slightly modified)

really also segregating the homologous and re-organised paternal and maternal chromosomes into separate cells in varying combinations. This is followed by the final division, in which the chromosomes divide longitudinally as usual, so producing the mature gametes. Accordingly, the life cycle of the organism is after this fashion—conjugation of paternal and maternal cells, cell divisions in which the chromosomes retain their general apartness, and conjugation of paternal and maternal chromosomes. Every nucleus, then, arising by the segmentation of a fertilised egg cell contains a double set of chromosomes, *i.e.* nuclear substance derived from both parents. The centrosome is usually that of the sperm, as the egg centrosome degenerates after maturation.

The question of the persistent individuality of the chromosomes has received very close attention. From a theoretical point of view the denial of their individuality seems to make mitosis meaningless. Why this careful and accurate division of the chromosomes, if, after every such division, the constituents of the different chromosomes are apparently jumbled up in a common mass at nuclear reconstruction? The assumption of their stability likewise gives us the better explanation of their constant number. From the practical side Rabl, so long ago as 1885, maintained, as the result of study of mitosis in the epithelial cells of the salamander, that the chromosomes do not lose their individuality between succeeding divisions, but persist in the chromatic reticulum of the resting nucleus. His idea was that the reticulum arose as the result of a transformation of the chromosomes, which gave off anastomosing branches, causing the temporary appearance of a network that was again lost as the reticulum contracted at various definite points to form the typical number of original chromosomes. Boveri, in particular, and others showed that whatever the number of chromosomes entering into the composition of a nuclear reticulum, the same number issued from it at a later stage, and in very much the same position. This was particularly striking in certain abnormal cases of fertilisation, where it was noticed that the irregular number of chromosomes persisted from one

cell generation to another, thus implying that "the number of chromosomes appearing in a nucleus during mitosis is the same as the number of chromosomes from which it was originally formed"¹ The same result is apparent in cases characterised by an "accessory" chromosome In other species the chromosomes appear to show constant differences of size and shape, so suggesting that they possess specific individual characters The further demonstration in many instances of what is probably universally true, namely, that in fertilisation the chromosomes of the two uniting germ nuclei do not themselves fuse, but give rise to two separate yet parallel series of paternal and maternal chromosomes which remain perfectly distinct throughout the succeeding cell-divisions till their conjugation previous to the penultimate reduction division, also seems to imply a measure at least of persistent individuality It may be that future research will confirm E A Minchin's "apparently sweeping and breathless generalisation" that the chromatin granules "are the only constituents of the cell which maintain persistently and uninterruptedly their existence throughout the whole life-cycle of living organisms universally,"² and that the regular and disciplined grouping of them in chromosomes preparatory to cell division is more of the nature of a brigading movement to ensure absolutely exact quantitative and qualitative division of the granules between the daughter cells Nevertheless in general an important, and even epoch-making discovery can now be referred to the proper quarter With Harvey's name we associate the discovery *Omne vivum e vivo* To Virchow we owe the induction *Omnis cellula e cellula* Strasburger first clearly established the truth *Omnis nucleus e nucleo*³ And with Boveri's name it seems probable that there will in future be linked the further truth that there are chromosome generations corresponding to cell generations, that the chromosomes of one generation arise endogenously in the chromosomes of a previous genera-

¹ C E Walker *The Essentials of Cytology*, p 92

² *Brit Assoc Report*, 1915, p 453

³ To this generalisation there are exceptions amongst the Protozoa

tion, that growth and reproduction, characteristic features of living things, are predicable of these intracellular units—in short, *Omne chromosoma e chromosomate*

The further question remains of the relation of particular qualities to the chromosomes—how far they may actually be considered to be the vehicles of inheritance. The facts of the reduction division involve an alternative distribution of the chromosomes that appears to exclude the possibility of their being the vehicles of the common racial characters—unless, indeed, all of them are present in every individual chromosome. The distribution that takes place when the paired chromosomes separate in the reduction division prevents a half of every one of the chromosomes going to the resulting gametes. But teeth are found in every creature in which it is a racial character, and if that quality only resided in some chromosomes the reduction division would imply its consequent absence in many individuals. On the other hand, if every racial character is present in every chromosome, it is not easy to see wherein lies the significance of a reduction division, or of the accurate longitudinal division of the chromosomes that ensures the practical reproduction of each chromosome of the zygote in every cell of the resulting body. Mendelism shows that certain characters are inherited alternatively, and the brilliant work of T. H. Morgan and his associates has even permitted of their making “maps” of particular chromosomes in the fruit fly (*Drosophila*) and indicating the position of the factors or elements corresponding to definite characters.¹ Again, some recent experimentation indicates that the cytoplasm, if only in a less degree, takes its share in the transmission of hereditary qualities. There is nothing to prove that this function is limited to the nucleus, and much is incomprehensible on any other supposition than that the cytoplasm—whose relations with the nucleus constitute the characteristic metabolism of the cell—has its definite share in heredity. In Conklin’s words, “the chromosomes contain the germ plasm, the cytoplasm is the somatoplasm, the

¹ T. H. Morgan and others, *The Mechanism of Mendelian Heredity*

chromosomes are chiefly concerned in heredity, the cytoplasm in development" ¹

Fertilisation, then, is a process by which the energy lost in a continuous cycle of divisions is restored by the admixture of living matter from another cell. It entails the blending of two independent lines of descent, the actual union of two linin-chromatic networks. Fertilisation, however, is not reproduction. Reproduction is re-production by cell-division; fertilisation is rather "a phenomenon associated with reproduction," although that association has become so close in the higher forms that they seem to be related as cause and effect. "The popular idea that fertilisation is reproduction is solely due to the fact that in higher organisms, if fertilisation is to occur at all, it must take place at that period in the life history when the individual is but a single cell detached from the parent—that is, *at* reproduction" ². In some parthenogenetic forms reproduction is secured without fertilisation, and in some experimental instances it has been artificially induced. When we go on to ask, What is the ultimate significance of fertilisation? we not only ask a question involving that introduction of teleological considerations which is by many held to be the bane of Science, but we raise an inquiry to which, though many answers have been given, a completely satisfactory reply has not yet been formulated.

Fertilisation as involving rejuvenescence of the conjugating individuals might perhaps be thought of as a kind of mutual assimilation arising out of a specific sex hunger, whereby two cells exhausted and bereft of essential elements of their economy unite, and out of the satisfaction is generated the energy of a new individual. It is not inconceivable that in the course of the long series of divisions the protoplasmic equilibrium of the dividing cell is upset, and that this is righted by the mutual attraction of cells lacking in, and charged with, specific qualities. In the case of the Protozoa conjugation

¹ E. G. Conklin, *Heredity and Environment*, p. 204. (The references are to the fifth revised edition.)

² L. L. Woodruff, *Foundations of Biology*, pp. 243, 251.

tion certainly has this effect, for it is always the commencement of a new series of divisions, in fact, strictly, it means the formation of a new individual in protozoon and metazoon alike. At the same time, as the result of the work of Woodruff and others on certain Protozoa, and the observed phenomenon of endomixis¹ in *Paramecium*, it cannot be maintained that fertilisation is intrinsically necessary for reproduction in all cases in this group. Weismann, on the other hand, saw in fertilisation a means of mixing germ plasms from two different sources, whereby variations were produced and multiplied. These variations were the material upon which Natural Selection was supposed to work in the production of new species. This was for him the purpose of fertilisation, and carried with it the implication that forms produced by binary fission or parthenogenesis were practically duplicates. Considerable variation has, however, been shown to exist in the case of forms reproducing by binary fission and parthenogenesis,² consequently no more can be said than that fertilisation is a source of variation, or is followed by it. Again, it is also possible to regard fertilisation as a means of checking variations, and so, on the contrary, of keeping the species true to the specific type. The offspring of biparental reproduction, instead of being more variable than either parent, is, so to speak, half-way between them, and so departs less widely from the mean than either of them. Indeed, the study of variation serves to indicate that, so far from producing new variations, biparental reproduction tends on the whole to eliminate such individual variations as are not directly the subject of selection. Accordingly, it is apparent that fertilisation, whatever its primary character may have been, is no longer a simple process, but comprises various aspects which may have varying importance under different conditions, although that of supplying a stimulus to development is an element in every case.

¹ Cf. Glossary and p. 84.

² J. Y. Simpson, *The Relation of Binary Fission to Variation*, *Biometrika*, vol. 1 No. 4, L. Warren, *Proc. Royal Society*, vol. lxx p. 154.

As the result, then, of some form of stimulus involved in fertilisation, the egg commences to segment. The individual cells or blastomeres, giving the appearance of isolation because of the concentrated nuclei packed around with nutritive matter, are yet in direct contact through strands of the linin network, which does not, however, prevent a certain amount of play of one cell upon the other. These cleavage divisions are similar to those that occur in ordinary cell division, the sole difference being that very early they are accompanied by differentiation. Differentiation in the higher forms of life is expressed in the establishment of tissues, and later of organs, in connection with that physiological division of labour that usually means so much greater capacity for doing special work. The more complex the organic structure the more detailed is this subdivision of labour: the greater the degree of co-ordination and unification of these activities, the higher the creature stands, as a general rule, in the scale of life. How all the different stages have arisen with their genetic continuity is the story of evolution, most interesting, if most difficult, in the lower grades of life, where, however, modern study, *e g* of the Protozoa, sheds floods of light upon the question. In the course of this differentiation considerable change is often noticed in the functions of the organs—what at one stage played one particular rôle is found at a later stage to function in a different manner.

Again, the cleavage divisions of the developing egg are often effected in planes that show some definite relation to the structural axes of the adult body. Typically the cells tend rhythmically to divide into exactly equal parts, and any new plane of division tends to intersect the preceding one at right angles. Variations, however, occur not merely in the rhythm and in the quantitative character of the divisions, but also in the direction of the cleavage planes; these variations are often of regular occurrence. Not merely do the cells divide in accordance with the requirements of definite mechanical conditions, but also, and more distinctively, with reference to the future cell orientation and structure

of the animal. The framework of the human liver, for example, is developed from the mesodermal layer of the embryo, the hepatic cells have their origin in the endoderm. "To bring these two structures together to form a liver implies growth from different points

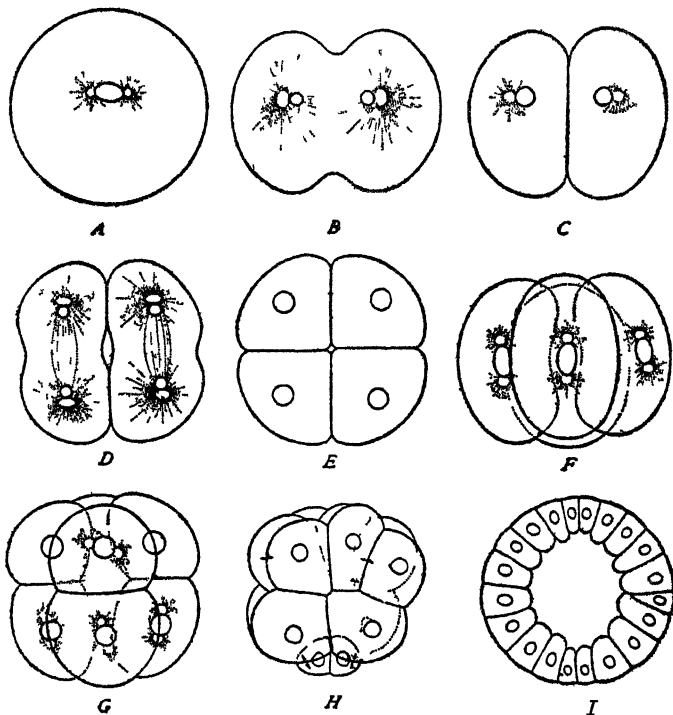


FIG 7—CLEAVAGE OF THE OVUM OF THE SEA-URCHIN *TOXOPNEUSTES* ($\times 330$). The successive divisions up to the 16-cell stage (H) occupy about two hours. I is a section of the embryo of 3 hours consisting of approximately 128 cells surrounding a central cavity (From Wilson's *The Cell*, by kind permission.)

and at the proper time"¹ Of this forward look, as of the unequal division that sometimes sets in as early as the first segmentation, and in every case appears sooner or later, no sufficient account has been offered

¹ J. G. M'Kendrick, *The Principles of Physiology*, p. 51

In fact, as Wilson puts it,¹ " we cannot comprehend the forms of cleavage without reference to the end-result " Study of all purely mechanical factors, such as pressure, form, etc , only makes it more obvious that the work is subordinated to that of some superior controlling law of growth

How far the later structure of the developmental form is already determined in the structure of the egg is the root problem of Embryology In many cases a definite relationship appears to exist between early blastomeres and the later adult areas to which they give rise in other cases, again, it becomes evident, particularly as the result of experiment, that there can be no definite, unalterable pre-localisation of parts of the egg In several cases the egg axis is not established until after fertilisation, and is even then experimentally alterable But no general consideration holds in any number of cases Cell formation and localisation of areas seem, ultimately, alike subordinate to some controlling formative process that expresses itself in growth Development takes the form of an orderly correlated progress towards a definite end The egg in each case in a remarkably short time evolves into a type about which certain general statements can be prophetically hazarded, but of the inwardness of this process no account can yet be given To speak of developmental capacities as being involved in the organisation of the egg is, perhaps, effective, but not informing at the most, an accurate descriptive account of the stages is all that is within the power of the biologist

The idea of pre-determination or pre-localisation of embryonic parts in the fertilised (possibly even in the unfertilised) egg cytoplasm has fascinated many workers not, of course, in the crude sense of the early evolutionists, who maintained the existence of a pre-formed though invisible embryo, or even in some cases of a miniature of the adult in the egg, but in the more general sense that definite areas, perhaps definite substances, in the apparently homogeneous cytoplasm correspond to definite parts which will later be built up

¹ *The Cell*, p 377

out of them. There are a great many facts that serve to indicate that the cytoplasm has considerable and sometimes specific regulative control in development. Segmentation would then simply reveal what is already predetermined. On the other hand, identification of the physical basis of hereditary with nuclear material demands that such cytoplasmic pre-localisation—if it exists—must be determined and controlled from the nucleus, and the attempt has been made, notably by De Vries and Weismann in their respective theories, to transfer the assumed germinal localisation from the cytoplasm to the nucleus. The differentiation corresponding to later embryonic regions, which is early noticeable in the cytoplasm, is induced secondarily through the influence of the ultimate nuclear units that migrate into the cytoplasm and direct its development. In Weismann's theory, development resolves itself into the gradual qualitative distribution of these units from their massed condition in the early cells, until at last in each cell there is simply left that particular determinant which controls it. But of such qualitative division, apart from the reduction division in maturation, there is scant evidence. On the contrary, certain facts connected with regeneration, and the ability of a single cell of the two or four cell stage to reproduce the whole embryo (*Amphioxus*, *Echinus*), although on a reduced scale, seem to negative it. Further, in the cases where, as in the frog, the right cell of the two-cell stage appears to contain the material for the right half of the body, that cell if isolated can yet in great measure supply the deficiency by a peculiar kind of regeneration.

Driesch, in endeavouring to solve the problem of developmental differentiation, suggested that the answer lay in part in the relation of a blastomere to the remainder of the embryo. "The relative position of a blastomere in the whole determines in general what develops from it, if its position be changed, it gives rise to something different in other words, its prospective value is a function of its position in the whole"¹ The suggestion bears a true relation to what does occur in

¹ *Studien*, iv 39

many instances, yet it is evident that not merely the position of a blastomere to its neighbours, but the position of its own constituents have to be considered, for Morgan has shown that even in the case of the two-

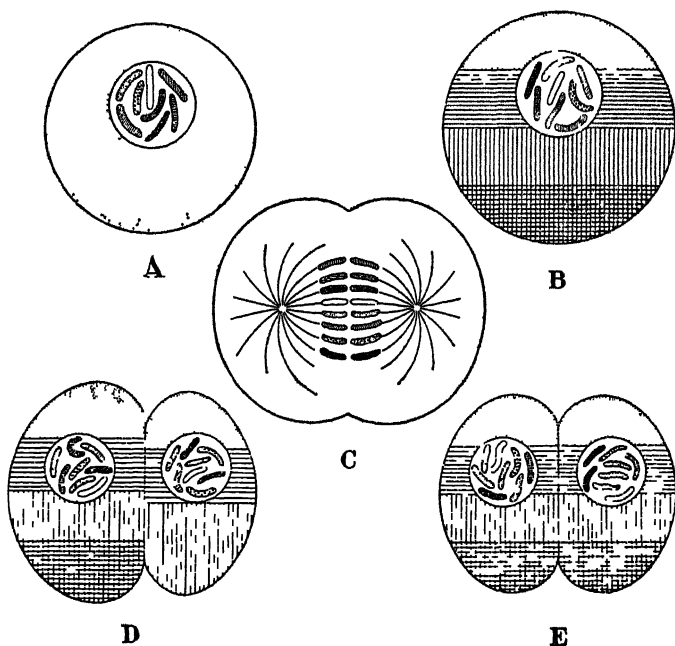


FIG 8—Diagram of zones of cytoplasmic differentiation and their distribution at the first division of the egg A immature egg, assumed to have no definite segregation of cytoplasmic stuffs, B, mature egg, with cytoplasmic zones established, C, first division of egg, D and E, two types of two-cell stages, D, *Dentalium* or *Cynthia* type with one cytoplasmic zone entirely distributed to one of the cells and therefore each of the two cells, if separated gives rise to an abnormal larva, E, *Echinoderm* or *Amphioxus* type, with equal distribution of the zones to both cells and therefore if separated, each of the two cells gives rise to a normal larva (After Wilson)

cell from the single isolated cell may give rise to a whole embryo of half size as in *Amphioxus*, or a half embryo, according as the isolated cell is turned upside down or left in its normal position. This seems to indicate that

all the material for a complete, if half-sized, embryo exists in the single cell of the two-cell stage, and that at this stage, as in *Amphioxus*, the blastomere is not so firmly set that it can only develop into the half of the creature that normally it would. In fact, embryology discloses a whole series of forms in which this equivalence of the isolated cells at the early stages is greater or less, some easily overcoming the tendency to develop only (as normally) into a part, others doing so with greater difficulty, and even failing, with the result that a monster (defective larva or adult) is formed. Accordingly it would seem as if in every case, even though we may have to go back to the pre-maturation stage, the egg cytoplasm is primarily equipotential in the sense that the various regions do not stand in a fixed relation to the parts that may develop out of them. Sooner or later, however, differentiation of these regions, resulting in a mosaic-like development, takes place from causes that we do not yet understand—sooner, *i.e.* before or at fertilisation, as in the case of the mollusc *Dentalium*, whose single cells when separated cannot completely overcome the tendency to form a part, and develop into monsters resembling pieces of a single embryo (and the same result is achieved by artificially cutting off pieces of the egg), later, as in the case of *Amphioxus*, where a cell of the two-cell stage or the four-cell stage may develop into a complete dwarf adult, either half or quarter size. A suggested solution of this phenomenon consists in assuming the various protoplasmic constituents as arranged in bands or zones¹. In *Amphioxus* the first division would divide these symmetrically and equally. In *Dentalium* the division may be apparently symmetrical but really qualitative, so that all of one band or zone passes into one of the cells.

But, further, it is difficult to surrender the belief that differentiation of a kind, slight perhaps but still effective, has occurred much earlier, even previous to fertilisation, for the egg has a developmental history antecedent to that experience. These axial differentiations are probably due to the nucleus—more particularly

¹ Cf. E. B. Wilson, *Science*, vol. xxi No. 530

to the chromosomal constitution and configuration—and form the scaffolding as it were within which the development after fertilisation goes on. The ability to readjust displayed by the isolated blastomeres largely depends on the degree to which this scaffolding has been effectively reared. For it must not be forgotten that this ability of the cells of an embryo to reproduce the whole organism, where it occurs, is confined merely to the earliest stages of the developing form. Cells do become differentiated, and this seems to imply nuclear differentiation of some sort, even if not after the manner of qualitative division. It is possible that part of the chromatin may be cast out of the nucleus, or dissolved, or be transformed into something else. The former circumstance has been indeed observed in the early somatic cells of the developing *Ascaris* by Boveri. Driesch's conception of the nucleus as a "storehouse of ferments which pass out into the cytoplasm and there set up specific activities,"¹ is at least interesting. Certain it is that "specific protoplasmic stuffs" are distributed to the cells in a definite manner during division, and since they have a definite arrangement in the egg, to this extent development is mechanical, and "the cleavage mosaic is an actual mosaic of different materials that are somehow causally connected with the development of particular parts."² If it could be shown that initially protoplasm contains only a few of these specific stuffs, that as development proceeds new stuffs are progressively formed and distributed under the agency of the chromosomes, and finally that the number of these substances decreases and that they weaken as differentiation progresses, we should have an interpretation of development that is essentially epigenetic—progressive in the sense that new additional parts not already there are formed—and in this combination of the two older and contrasted viewpoints of preformation and epigenesis, the truth is probably to be found.

With all this we must not forget the dominating

¹ E. B. Wilson, *The Cell*, p. 427

² E. B. Wilson, *Science*, vol. XXI, p. 288

rôle of the environment in all development without its stimuli the inherited organisation of the living creature would not work itself out. The living form is at any moment the resultant of external stimuli acting upon its inherited organisation. This has been proved experimentally time and again. A normal development is the response to normal conditions. In the case of the humbler forms of life the character of the response is mainly determined by the inherited organisations. As life advances, inherited organisation gradually counts for less, until with man the environment may have the last word. The developing organism and its environment react the one upon the other independently, yet in virtue of its adaptiveness the organism is progressively able to set itself free from the control of the physical environment and prove itself the more victorious of the two. Their separation is, however, practically impossible. We are almost compelled to consider the organism and its environment as a single system undergoing change.

In conclusion, we reaffirm that in that marvellous co-ordinating power that guides individual development in a rhythmical and orderly fashion to its goal, we find that which is ultimate. Of its existence there can be no doubt, for we have become aware of it at many points of our study. We see it in various adjustments and regulations that characterise outstanding features in metabolism, *e.g.* the maintenance of a practically constant quality and quantity of the blood. We see it in the wide range and intense specificity of the relations that are involved in immunity¹. We see it in the segregation of distinctive cells for the modified repetition of the parental history. We see it further in the marshalled progress of these cells to a distinctive and predictable end in the production of a complex organism functioning as a unity, and that in spite of their proven capacities, at least in the early stages, to serve in other ways, in spite also of the appearance at later stages of localised self-differentiation and independent development. Most

¹ H. Driesch, *The Science and Philosophy of the Organism*, vol. 1 pp. 204-209

markedly, is it in evidence in those pathological cases where, after artificial rearrangement or destruction of some of the cells at an early stage in development, the particular destiny is yet harmoniously achieved in a way that excludes the crude conception of an underlying mechanism. What this ordered control is in itself we have no knowledge. This autonomous control and guidance for a definite end—the typical adult form of the organism—is that which rides athwart the various forces at work in the arena of the living form, non-factorial, yet uniting all other factors, it is that wherein livingness consists. In any description of organic phenomena, as we have seen, we find ourselves treating of physical phenomena, *e g* osmosis, surface tensions and so forth, but though they enter into the account, they do not account for life. Indeed, they are simply in its employ. We fling the fine-drawn network of our physical and chemical concepts over the living thing, thinking that we have encompassed it, but it comes oozing out through the meshes and cannot be held, for it is subtler than all our thoughts of it. As Wilson puts it, “we no more know how the organisation of the germ-cell involves the properties of the adult body than we know how the properties of hydrogen and oxygen involve those of water”¹. In the case of the individual history whereby the acorn develops into the oak and not into an elm, and the fertilised egg of the butterfly travels by a wondrous road to its destiny and not along any of the other 250,000 insect routes, we may marvel at this power, but in the history of the race, where the steps have been infinitely greater and the time element immensely longer, we behold it in yet greater glory.

¹ *The Cell*, p 433

CHAPTER V

EVOLUTION

IN the varied modern uses of the term "Evolution," we may see an interesting example of a word outgrowing and outliving its original significance, till it has developed a wealth of connotation that embraces the universe itself. Originally, the word Evolution was applied to a specific theory of the origin of the individual life which was held by certain eighteenth-century naturalists. They believed that every egg contained a preformed invisible rudimentary structure that corresponded, part for part, to the adult form. Thus development was the unfolding and transformation of a pre-existing structure, not the successive formation of new parts. Just as one day the tightly closed sepals of the green bud unfold and disclose the coloured stamens and petals that have apparently been growing under their cover from mere miniatures in secret, so did the old evolutionists (or preformationists) consider that the diminutive transparent parts of the germ gradually grew until the day of their manifestation to the outer world. To this theory the name of Evolution was given. Observation quickly showed that no such simple growth took place, and a more correct view was enunciated in the rival doctrine of Epigenesis, viz. that development was no mere unfolding of parts already existent, but the gradual and continual formation and differentiation of structures and organs not previously existent as such in the egg. The word being useful, however, was retained to express the idea of development in general, and while originally applied to the growth of the organic individual, whether plant or animal, from the egg, was soon employed in connection with the development of

features related to human life, such as language, political constitutions, etc., and has even been transferred to the realm of the inorganic, and finally to the process of the universe itself¹ Such transference is not a recent movement Swedenborg and Kant indeed held theories of Cosmic Evolution though not in name, in the types of nebular hypothesis associated with them To-day, on the other hand, modern physics is specially busied with the evolution of the atom and the transmutation of the elements Organic evolution occupies but a moment in inorganic evolution, which has been the immensely longer process, yet we are not prepared to consider the latter as therefore the more inclusive process, or to think of the former as but an incident in the latter

In all these varied processes of "becoming," the root idea is that of change Evolution is the history of changing forms, organic or inorganic, as affected by unchanging laws The process of inquiry has been marked by the persistent dissipation of associations of permanence with the material—planet and atom alike prove to be unstamped with it—and by the emergence of conceptions of spiritual energy as that which alone endures When inquiry is made into the character, direction, and ideal significance of these changes, we go beyond the merely descriptive account, and the facts of Evolution become the basis of a philosophy²

The facts of change have only been gradually appreciated in their tremendous significance Nothing organic or inorganic is as it was half an hour ago, even as no one dipping his hand in a river can be twice wet with the same water, and all these changes are greater than they appear We recollect the old-time dictum, that the substance of the human body is entirely changed within every seven years, but a 24-hour record of a human life in a scale pan would show a continuous oscillation of level, corresponding to the varying weight

¹ In some instances with misleading and question-begging results Cf Prof J Arthur Thomson's admirable work, *The System of Animated Nature*, Lecture I

² As e g Herbert Spencer's *Synthetic Philosophy*

in body To-day we have learned to extend these records of change past the individual life to that of the species, the class, the race Yet fixity of type was the catch-word of science in the middle of last century, the everlasting hills are still the joy of poetry "I believe," said the rose to the lily in the parable—"I believe that our gardener is immortal I have watched him from day to day since I bloomed, and I see no change in him The tulip who died yesterday told me the same thing"¹ Because of the shortness of human life compared with the duration of the world processes, men spoke of individual things, even of species, as permanent—as if a child should gaze at a clock for a moment and roundly declare that the hands stood still Brief as the lightning flash, with its momentary revelation of seeming repose amidst the agitation of a stormy night, is the life of man compared with the chronicles of life in Nature Similarly, under the casual flash of his untrained intellect, the phase of Nature amidst which man momentarily moved, appeared to him unchanged and motionless From this illusion in part there arose the theory of the permanence of type, an illusion that still persists in the tendency to consider the phenomena of heredity as more fundamental than those of variation

Most commonly the term Evolution is used to denote that theory of organic existence which accounts for the origin of organs and of species by divergence and development from ancestral stocks, or, in a narrower sense, maintains that all the forms of life now existing, or that have existed, on the earth, have sprung from a few primitive forms, possibly from one This theory was at first merely a working hypothesis, but all contrary hypotheses have long since ceased to work Its success, particularly in explaining many phenomena of detail that are otherwise inexplicable, has been especially impressive Things are because of their significance, and like some new Rosetta Stone, Evolution supplies a key to numbers of hitherto undeciphered data All modern biological investigation assumes its truth In fact, no naturalist whose studies give him the right to

¹ Quoted in D S Jordan's *Footnotes to Evolution*, p 56

an opinion on the origin of species now holds the older views, he could not do so and "look an animal in the face"

In ordinary usage the terms Evolution, Organic Evolution, and Theory of Descent are often employed synonymously, but it is important to note that the term Evolution is not strictly equivalent to the unfortunate word "Darwinism." Evolution is a theory as to the general method by which species have been introduced into the world, independent of any idea as to the causes or agencies which have brought about their introduction. Darwinism was Evolution, but it was something more, it was at the same time an attempt to explain the causes of Evolution. It not only claimed that species have been slowly evolved from one another, but particularly in Natural Selection, as also in Sexual Selection and the theory of Pangenesis, it offered some account of the manner in which they have arisen and of the laws which govern their gradual modification. Accordingly it is possible to accept Evolution and yet at the same time to reject Darwinism, *i.e.* it is possible to believe that species have been evolved from each other, but to deny that Darwin suggested a sufficient cause for this Evolution. Indeed, while biologists were never so certain about the fact of Evolution as they are to-day, they never were so uncertain as to the actual factors in the process and their relative importance.

In any discussion of the relations of scientific and religious thought, Evolution will find a place if only because of its potency as a unifying agency in the world of data. The conception of the unity of knowledge naturally suggests the idea of foundation lines along which this stately temple shall be built. Such a foundation line is Evolution, extending so far as is known through every department of knowledge, and offering a beautiful example of the mutual benefit to one another of the scientific and the theological outlooks on God and the world. For while in its light the scientific theologian has reached in some respects a nobler and a purer conception of God, he can also show that without the in-

clusion of a purposive factor or aspect Evolution can in no sense pretend to completeness or satisfactoriness as the story of the world For him intention is the bond that binds him to Nature and links both with God, the world that he inhabits is a "realm of ends" In Evolution men have come to perceive the divine method of creation in time, even as gravitation concerns the relations of things in space It forbids us any longer to think of the world as of some structure carpentered at a definite point in time, rather does it teach us to look upon it as a growth The Paleyan symbol was a watch, the type of Evolution is a flower and while the watch stopped more than half a century ago, the flower is still a living, reproductive, progressive, and didactic thing From it we learn that development is gradual, "first the blade, then the ear, after that the full corn in the ear",—that is Evolution in the individual life It teaches us in a way that we had not realised before, that the present is the child of the past by direct descent, and that the future has its roots in the present It makes us regard revolution as unnatural, and it also shows us that reformation may be very slow It compels us to take a larger view of things—not to estimate the stream of life by the little circling eddies, nor yet by the contrary surface currents such as may often be seen on mile-broad Asiatic rivers, but by the whole flood, grand, full-watered, irresistible, as it sweeps towards its ever-nearing goal There are, of course, the eddies, for advance in any given direction may not be uniform, there are the backward surface currents, for palæontology tells us of apparent recession in the progress of individual species, there are the rapids, for successive strata sometimes disclose a quick advance in the development of forms under congenial circumstances, there are the pool-like, seemingly motionless tracts, for we have evidence of partial temporary stagnation in the otherwise progressive movement, of genera that often rested, marking time in the age-long march We must not judge the stream by the eddy or the counter-current, by the rapid or by the pool-like tract, but by the whole course

Evolution accordingly may be defined¹ as a process of continuous, orderly, and broadly progressive change, from the simple to the more complex, which arises as the resultant of various factors, operating from within and from without. Typically we see it in all embryonic development, that marvellous process by which a fertilised egg-cell grows by segmentation and concomitant differentiation into an organism of its own species. In the development of the hen from a microscopic germ-cell through the intermediate stage of the chick into the adult, we have an instance of continuous, orderly, and broadly progressive change, from the simple to the more complex, which arises as the resultant of various factors operating from within and from without.

But the statement implies more than at first appears. Evolution is change with continuity.² This we know to be the case in every instance of individual development. Bird and beast, fish and creeping thing, man himself, all begin life as a single cell—commence where the Protozoa left off—and so pass through many different stages into the adult organism of their kind. In this instance the terms of the series obviously have genetic connection and continuity. With regard to that other series, so imposing in its grandeur, beginning with life itself in the far-back pre-Cambrian days and comprehending all the countless forms that have peopled the Primary, Secondary, Tertiary, and Quaternary eras—forms likewise growing in complexity of structure, in the mutual action of their correlated parts, and in their interaction with the environment—the evolutionary suggestion is that its terms likewise have a genetic connection and continuity, and leave their impress on the individual series.

If Evolution implies continuity, it is inconsistent with the idea of "breaks" in the succession. A clear understanding at this point would mean the solution of half of our difficulties. Everything, of course, will depend upon the content of the word "break." When

¹ This definition is a modification of that set forth in Le Conte's *Evolution and its Relation to Religious Thought*, p. 8.

² i. e. of content, rather than of time.

the temperature of water is raised from 99° to 100° C under ordinary atmospheric pressure it vaporises in a certain sense there is a "break" The study of mutations is a study in "breaks" Yet whatever be the series, organic or inorganic, every term is in some degree linked to that preceding it Something from a preceding stage is always carried over to the next There is never absolutely complete initiation If creation is held to mean production out of nothing, initiation without any precedent relation, it is an effect that is contrary to all experience and in which there is nothing of Evolution Such absolute "breaks" are commonly cited at the commencement of the evolutionary process, at the dawn of life, at the appearance of sentience, at the awakening of self-consciousness An older apologetic filled in the "breaks" with divinity, but what it fondly considered to be its strongholds proved its most vulnerable points The difficulty about these "breaks" is that they are supposed to occur at periods about which we have no knowledge, and of which we can never hope to learn the exact conditions Thus Principal Chapman's "vast diffusion of ultimate units of Matter, each like the other in every respect, each subject to equal pressure and tension,"¹ awaiting some divine contact—some breath, some touch—to start it on its evolutionary career, is wholly hypothetical With regard to the dawn of life it does not follow, as has often been pointed out, that although Biogenesis is the only known law of reproduction to-day, the conditions requisite for Abiogenesis have never occurred We cannot say definitely what these conditions were, yet we can be tolerably certain that the lands and, particularly for this purpose, the seas of late Archæan times were very different from any modern conditions, terrestrial or marine They are conditions that will never return, and are not humanly reproducible The belief in such a natural origin of life is an exigency of thought Again, if the term is employed in its broadest significance, the appearance of sentience, *i.e.* irritability, synchronises with the

¹ C Chapman, *Preorganic Evolution and the Biblical Idea of God*, p 151

dawn of life, and another break has been removed. We are left with the awakening to self-consciousness. But even this crisis presents no difficulty to the modern scientific mind: as a matter of fact, it is actually bridged in the development of every child.¹ There is no evidence of breaks: evolution is change with continuity, and God has been immanent from the beginning. In the process there is a great deal that is little understood, and much that is unknown, but the days are past when the unknown, the gap in our knowledge, can be emphasised as the sure abode of the divine. Rather is it realised that the whole process is instinct with divinity, and nowhere is it more obvious to the religious philosopher than in the great fact of direction in general and in detail which compels him to insist on the recognition of a directive factor in opposition to all ultra-mechanical conceptions of Evolution. The realisation of the inorganic and the organic as constituting a broadly progressive, developing whole which has issued in man, the superlatively purposeful organism, means that we are in and of a process which in whatever degree it be mechanical, yet has about it that which mechanism can never completely explain alone. To recognise the spiritual aspect of Evolution is to believe in it as directed by an overruling yet indwelling purpose, a process with no breaks but of rare continuity and yet with "increments,"—crises greater in their implications than in the actual moment, points after which everything thereafter moved in a new dimension, as in the birthday of life—flood plains of the river of life which marked successively higher contours in the regions of the world's action, as in the dawning of self-consciousness, and the appearance of Jesus Christ.

But it is more: it is continuous, orderly change. The order is the expression of what is often called "the reign of law." In science the connotation of the term is very different from that which jurisprudence attaches to it, and in consequence of this ambiguity some writers have been led into strange confusion.² In the latter

¹ Cf. p. 262

² For examples see article "Law" by Prof. Hearnshaw, *The Hibbert Journal*, vol. vi No. 3

sphere we associate with the word the conception of something “(1) expressible as a distinct proposition, (2) addressed to the will of a rational being, and (3) enforceable by a sanction”¹ In the realms of science the idea is quite otherwise there it appears as an abstract or general conception of a supposed universal uniformity of action deduced from the observation of illustrative phenomena in a limited number of instances In formulation a law of science should always take a conditional form—if such and such conditions are present, such and such results will follow Nevertheless, the law is simply a generalised statement, a conceptual shorthand report of Nature’s observed uniformities of action, and never can be anything else than a more or less provisional hypothesis to minds experimentally less than omniscient The confusion arises in identifying the ascertained sequences themselves with the law, whereas it is but a statement of them, or in hypostatically conceiving the law as the energy or force in virtue of whose uniform operation the observed regular sequences take place, and so subjecting phenomena to it, as if the law were an objective determining agent From this it is but a step to carry natural laws behind phenomena, and regard them as pre-existent necessities which explain everything but are themselves in no need of explanation Strictly, however, we know nothing of what is necessary, our knowledge is simply of what has been proved to occur under specific conditions Natural laws may apply in any particular series of circumstances, they do not, however, necessarily *imply* According to Newton’s Law of Gravitation, every particle in the universe attracts every other particle with a force which acts in the line joining them, and which is directly proportional to the product of the masses, and inversely proportional to the square of their distance apart Why might it not have been inversely as the cube of the distance? A natural law is simply the expression of a relation it is not the relation, still less is it its cause

In the article referred to, Professor Hearnshaw shows

¹ Holland, *Jurisprudence*, p 21, quoted by Hearnshaw

ow in the moral sphere both senses of the term find application, and call for even greater care in discrimination. Moral law appears both in the form of sanction—enforced precept—and uniform sequence. “Pray without ceasing,” says St Paul ¹ “This is the confidence that we have in Him, that, if we ask anything according to His will, He heareth us,” says St John ² The deepest sanction arises from recognition of the results of such uniformity in human life, and when one reflects on the *Cause* of the uniformity, the latter in its results comes to take on the form of an implied command. And inasmuch as no series of sequences ever makes a law, this aspect of law as that which is commanded or ordained becomes ultimate. The affirmation of natural law is the affirmation of something more than mere series of sequences. It is the acknowledgment of a persistent and sustaining cause of these sequences, which we are driven to find in the Divine Energy itself—energy expressive of and emanating from the Divine Will. But this Will in turn is but an expression of the divine Mind—it is, in short, that mind in action—so that the “reign of law” merely comes to be the physical counterpart of the divine immanence. The physicist looks at the data and says, “It is all law” the philosopher ponders them and concludes, “It is all mind” but the greatest induction is that of the man who has lived through it all, noting the resultant of the various sequences in the case of his own experience, and who can truthfully say at the end, “It was all love”

We have already seen that the advance of science consists in the recognition of ever increasing numbers of these grouped relations which in their constancy and interaction elicit our admiration. They are the result of processes all of which are natural, and it is the ideal of science to give a complete account of them all. The reaction of man or the growth of a state are as much natural processes as the flowering of a lily or the growth of a sand dune. And all are supernatural in the sense that they are alike expressions of the invisible solidarity of the universe, the immanence of law, and the im-

¹ 1 Thess v 17

² 1 John v 14, cf also 1 John iii 22

perishability of energy Science has her ideal, but however much we may feel doubtful as to the ability of the human mind to realise all the laws, for example, of the science of life, yet we are none the less sure that these laws never fail This very uniformity, however, the basis of all scientific endeavour and the comfort of the religious mind,¹ has in many cases by a curious inversion proved the greatest stumbling-block to religious faith To such minds the only proof of Deity for an age of scepticism would be to see a law of Nature definitely broken, to see *eg* a real burning bush unconsumed, and so have it demonstrated that the Energy that expresses itself in law can also show itself in lawlessness, and so prove itself superior to all its limitations and usual epiphanies Thus in the confusion a false emphasis is laid upon the miracle The most the miracle can do is to draw attention to the eternal truths with whose promulgation it is associated These truths relate in part to the essentially spiritual character of the world, and once this has been grasped the individual miracle becomes but an episode in the greater miracle of the whole It has been remarked that Emerson in one of his Essays speaks of a man's purpose in life "to be sound and solvent," and Emerson's life at any rate seems to have had this character, whence we may conclude that such a rule of conduct was his own "But one may say, 'This is only a human resolution The man himself should be above all rules and requirements of his own making Let Mr Emerson show that his life is above his principles Let him break these rules to show his power Let him be unsound and insolvent for a time Then only will his real greatness appear' But the soundness and solvency were the expression of Emerson's life without these he would not be Emerson"² In like manner the laws of Nature are the expressions of the soundness and solvency of the Infinite Energy A broken law would be the expression of unsoundness and insolvency It would mean the failure of the universe in that sense law can never be broken The demand of those who would see broken

¹ James 1, 17, Heb xiii 8

² D S Jordan, *op cit* p 61

laws is the same as that of the scribes and Pharisees for a sign,¹ and no sign shall be given them. For the man who cannot see the touch of divinity in the life-activity of the cell or in the autumn colouring of leaves, who cannot realise the majesty and power of God in the order and uniformity of Nature, who cannot so put himself in sympathy with Nature that Christ's words concerning her seem to him instinctively words of truth, and so words of God because they are the words of truth, has injured his soul and will not believe though one rose from the dead, still less *that* One rose from the dead. To demand such interference is to go back to the early Israelitish conception of a capricious God. And yet no one can dogmatically affirm that God does not interfere. Man interferes with the order of Nature, and what is possible with man may well be possible with God. Man interferes, but ever in obedience to other laws. And so may God interfere, but in no lawless way—rather through the medium of relationships or laws other than those that are already open to our comprehension.

Again, many are distressed because of the apparent insensibility of Nature. She goes on with her own affairs. Mont Pélée's fiery flood envelops sinner and saint alike. Messina falls on the just and on the unjust. Yet this attention to her own affairs, this "just keeping on the same," as we say, is simply the expression of the solidarity of the universe. A law of Nature is no respecter of persons, nor an executor of human justice. Just as a varying multiplication-table would be the destruction of mathematics, so would a varying law of Nature be the destruction of the universe. Constituted as man is, life would be impossible even for a day if there were no basal uniformity of Nature. Without it experience would be valueless, there could be no knowledge, no inducement to labour, no pabulum for faith. Not otherwise could Nature have ever been an orderly and beautiful means of intercourse between man and God. And even where a temporary phase of Nature's process seems to man to take the form of a disaster, it

¹ Matt xii 38

might be well to inquire whether that principle of judgment is soundly and broadly based which condemns that which has hurt him. For if in some inscrutable way men were at the eleventh hour rescued from the consequences of some natural process, they would have gained their preservation at the cost of their lost sense of law, they would feel themselves the victims of chance, and much of the motive for right conduct would be gone.

With regard to Messina¹ we must realise that given the world as it is—and the real understanding of what it is more than removes the difficulty—such a catastrophe is but a special case of the general problem of death. In a world where, let us say, 30 million people die annually of disease, accident, or physical exhaustion, the fact that 100,000 died in such contiguity as at Messina is indeed appalling, but in itself, apart from the mere fact of numbers, not more so than the sudden death of any intimate friend. Each one of these men and women died, could die only once: there was no violation of the order of Nature, and an innocent saint who happens unwittingly to stand athwart the forces of Nature will suffer, yet not in his soul. But the righteous perished with the unrighteous! Even if the naive assumption that such a calamity was a judgment upon sin were defensible, the profounder fact would remain that the infinite shame and punishment of the wicked just is that they involve the righteous and innocent along with them. By slow degrees man wins the truths that set him free at once from the torment of mental fears and the tyranny of natural forces: this is the story of his evolution. Yet even in the highest civilisation and under the most beneficent political régime he may live a captive in the prison of his fears, if so be he has no sense of his immortality. But in the mind that realises that God "hath set eternity in the heart of man," that human life is but a stage in a long process of growth, that in reaction with the assertive forces of Nature man has come to be what he is, so that out of disaster has often come individual and racial salva-

¹ The reference is to the devastating earthquake in 1908

tion alike—in such a mind there is a certainty of good that the fires cannot quench nor the shakings of the earth remove

But Evolution is something more it is continuous, orderly, and broadly progressive change, from the simple to the more complex To say “broadly progressive” is simply to read the facts At the same time it should be clearly understood that Evolution and progress are not synonymous, convertible terms Evolution is not an innate tendency towards progression There is no single law of progress in Nature, nor is progress in any group a necessity regardless of conditions Degeneration may be there, or, it may be, through many a generation the type persists unchanged The laws of Evolution have in themselves no necessary principle of progress Their functions, each and all, may be defined as cosmic order Evolution is continuous orderly change, but it is only when we regard the stream of life as a whole, without fixing our attention on the pool-like tracts and the contrary surface currents, that the general progress is appreciable

Inspection of the geological record discloses the fact that the different eras have been dominated by some one class in particular, and that with the advance of the ages the members of these ruling dynasties have belonged to successively higher orders in the animal scale Mollusc, fish, reptile, and mammal, roughly characteristic of the Pre-Silurian, Silurian, Secondary, and Tertiary eras, each had its day of power and then fell before the fitter successor Yet though they lost the sceptre they did not utterly perish, but proceeded to occupy a humbler station The organic kingdom has ever risen in its highest forms, and become more and more complex not merely in organisation and behaviour, but in range of commerce with, and adaptation to, the environment The evolutionary process as a whole shows “progressive differentiation and integration along diverse lines, and increase in the complexity and masterfulness of behaviour, a growing emancipation of mind, and an approximation to personality”¹

¹ J Arthur Thomson, *The System of Animate Nature*, vol II p 380,

There is evidence of a rhythmical movement in which creation, both in classes and types, is carried onwards in successively higher forms that bear definite relations to preceding forms

Finally, Evolution is a process of continuous, orderly and broadly progressive change from the simple to the more complex, which arises as the resultant of several factors operating from within and from without. Of these the best understood are the following: Heredity, in virtue of which like tends to produce like, Variation, resulting in the divergence and differentiation of types, Environment, Natural Selection and Sexual Selection, Isolation, physiological and geographical, Altruism, and what for lack of better language may be termed the Directive factor or element, although, strictly, it is not a factor in exactly the same sense as the others.

For our ultimate theory, whatever it be, must be one that will cover the whole range of experience down to the last detail. And while Nature appears as a realm whose operations are everywhere orderly and capable, so far as they are understood, of being expressed in the shorthand formulæ that are familiar as her laws, yet is it just as certain that we find her capable of modification not merely by the human will realising itself in and through these laws, but we also become aware of other modifications on a larger scale (*e.g.* the formation of the Carboniferous flora, the efficiency of the Ice Age in the formation of soil seen in the transporting of great rock masses, the increased grinding of surfaces to gravel and clay, and the intensified action of expanding river systems), whose postponed as well as immediate utility tends to suggest that they find their origin in the Divine Reason. At any rate such a conception would appear to be more true to the totality of fact than that mechanical view alien to thought and purpose whose sole function seems to be the maintenance of the sum of the kinetic and potential energy in the universe as a constant quantity.

It is here, then, that we find the dividing line between interpretations of Nature that are merely mechanical and those that find in her spiritual significance. The

data are, of course, unaffected, whatever be the theory of them, they are always there. Any change in our theory about the data will not affect the data, it may affect ourselves. It is only by a thorough examination, not merely of the evolutionary process, but of each of its several factors, that we find their insufficiency to account for that in which they play a part.

With regard to the factors, it is in no way difficult to show that those of the forces composing them which are immediately the expression of purely physical conditions, are a comparatively insignificant part of the whole. Spirit is there and at work, evidenced by the character of the whole. When it is denied in the broad sense of the religious evolutionist, it is introduced not merely into the particular unit like the cell, but even into the atom by the hard-pressed Haeckelian. The law of the Conservation of Energy states nothing, *e g* as to when—quite apart from conditions—one form of energy is changed into some equivalent quantity of another, or into which it is so transferred—that depends upon many qualitative factors. However expounded, the mechanical solution only partially succeeds in setting forth the series of changes that are the most obvious components of the process, and fails in any explanation of the concurrent changes in the progressive whole. The mechanical theory tells us truly that given *a*, *b* will follow as an effect, but it does not tell us why *a* is given, we are left in ignorance why *b* and not *c* is the resulting effect—or if answer is given, it is found in a barren necessitarianism out of which you get exactly what you put into it. As Professor E G Conklin very truly remarks, "In all mechanistic sciences, from mathematics to biology, we introduce in one form or another in our factors the qualities which we seek to explain in the end product"¹. It is this "why" that constantly reminds us that our mechanical conceptions are after all mere abstractions, that reality may be something that obeys our abstract network of law, and yet is something greater than law, greater than all our explanations of it.

¹ "Problems of Organic Adaptation," *The Rice Institute Pamphlet*, vol viii p 367

Indeed, we find that as the chance element is more and more eliminated—and that is directly in proportion to the advance of knowledge—the certainty of direction becomes more and more impressive. Darwin based his theory on fortuitous variations, and an indefinite number of them. The modern reply is that variation is a definite thing, and inquiry is meanwhile directed into the origin of these variations. "The materials for natural selection are furnished by the *ensemble* of an enormous number of characters, each of which is a unit pursuing its independent history and fluctuating and mutating and moving in direct lines under laws which the philosophic palæontologist has proof of, but totally fails to understand. Consequently he assumes the agnostic position that there is some principle, or principles of direction, or better 'unknown agencies,' still to be discovered other than the principle of order coming out of fortuity"¹ It is recognised that it is not the survival of the fit that calls for remark, as Schurman long ago pointed out. What excites our interest is the question, not of their survival but of their arrival, it is the question of the origin of that fitness itself, for there is no wonder in the survival of that which is fit to survive. Now, if this arrival is in every particular definite, if evolution takes place along definite lines of growth with no break indeed, but with significant crises, then every causal force is retained in full activity as the naturalist requires, but in addition there is some hinted explanation of the systematic character and the continuity of the results. It becomes increasingly hard to believe that that in the world which mind interprets to be kin to itself should have another origin. On any other view the irrational produces the rational.

Evolution thus spiritually conceived enables us in large measure to harmonise the natural and the supernatural, between which there is substantial unity in spite of their diversity.² It relieves us from all embarrassment of a time element. It places us in the midst

¹ H. F. Osborn, *Science*, N S vol xxix No 753, p 896

² Cf p 248

of the creative movement, and compels us to think of God as actively determining, rather than as having determined, events. In a way that was never before possible it shows us what it is to be fellow-workers with God, and suggests that as in conversation with our friends and observation of their activities we come to know their mind and intents, so in communion with God, and in investigation and reflection upon His processes, we may so learn His Will for ourselves and for the world as to put our lives efficiently into line with the eternal purposes. "My Father worketh hitherto"—that eternal work receives a new content, "and I work,"¹ and so must we. That for which the spirit of man has longed, that which he found in the miracle—the evidence of a spiritual process in the world ready to exert itself in behalf of a divine order—is for ever secured in the evolutionary conception of the divine immanence. It is almost needless to remark that thus to conceive of Evolution involves no change in our ideas of the love and power of God, these ever abide. All that we have attained is a more orderly conception of the method of the divine working, a method that explains the whole process, showing Him abundantly immanent in a world that is yet in Him. God becomes known to us in certain of His attributes as an ever growing revelation. He is on record no longer the fixed formula of the Schoolmen, in experience not even the perfected presence of the Pietists.² For truth itself as we know it is gradually found to be no longer the absolutely immutable thing that we conceived it to be. The data of to-day are modified and subsumed in the more comprehensive data of the morrow. Incessantly the mind pushes on, and the truth gained at any one point is an indication of the direction taken by the Supreme Reason, a hint of a foundation line, rather than an absolute final product.

Evolution thus conceived is not a creed, nor a new religion, nor a body of doctrine to be believed without being understood. It is not a panacea for human ills, it will not settle strikes nor provide a remedy for lovers'.

¹ John v 17

² Cf J Bascom, *op cit* p 183

quarrels Dr Woods Hutchison has indeed entitled a book *The Gospel according to Darwin*, but there is no saving grace in Evolution, unless that it saves a man from pessimism. If he is inclined to despair of the progress of the race, let him but turn and see the road by which it has come, or look unto the rock whence it was hewn, and to the hole of the pit whence it was digged.¹ Evolution does not, indeed, explain the origin of life, but it helps us to understand the origin of the different kinds of life.

¹ Is. li. 1,

CHAPTER VI

NATURAL SELECTION

WHEN we speak of the proofs of Evolution, we do not mean anything in the nature of an Euclidean demonstration such proof does not exist Nor is there in strict speech any unequivocal objective demonstration of the doctrine of descent The whole argumentation is strangely subjective The evolutionist believes in descent not so much on irresistible isolated objective data, as on logical induction from curiously scattered, always incomplete, lines of evidence Yet in every case the hypothesis of descent covers the facts, and nothing is known that is in vital conflict with it

For those who have lived all their days in an age whose Open Sesame has been "Evolution," it is not easy to realise the tremendous revolution in thought that followed the publication of Darwin's work entitled *On the Origin of Species by means of Natural Selection and the Preservation of Favoured Races in the Struggle for Life* (1859) The modern difficulty, indeed, is to understand how it was ever possible to entertain any other ideas about the origin of species than those that in general obtain to-day The real change, however, has taken place in connection with our ideas of what a species is here rather than in ideas about their origin lies the chief difference between pre- and post-Darwinian thought It is a fair question whether after all Darwin told us anything that is absolute about the origin of species, but he did show us that there was nothing in creation that corresponded to the older naturalists' idea of a species And once that old conception was dispelled, the correlated ideas about the origin, relations, and fate of species naturally went into the melting-pot as well

The species was the pre-Darwinian unit of classification. It was selected because the fluid character of the included varieties was known, while the relationship of the more comprehensive groups (genera, families, orders, etc.) was distant and in great part unknown, again, species seemed to correspond to the various "kinds" after which it was believed the Creation Narrative affirmed the Creator to have fashioned the world of life. Further, varieties were cross-fertile, with species was introduced cross-sterility—the divine barrier set for the preservation of organic order. Species were accordingly immutable, and speculation concerning their transmutability was as vain as the meditations of an obsolete alchemy upon the possible transmutation of metals. Such was the static view of the organic realm which dissolved under the play of the Darwinian searchlight into a dynamic representation of living forms. Yet many proofs of organic evolution are more correctly regarded as disproofs of the old conception of a species.

The details of such proofs and disproofs may be gathered in numbers of appropriate text-books¹. They arise out of considerations that are physiological in character, dealing with the functioning and nature of living forms. To these may be added morphological data dealing with the structure of forms, historical arguments drawn from the racial and individual history, and finally geographical indications, based on the terrestrial distribution of plants and animals. In illustration of a physiological disproof of the older view, reference may be made to the modern position regarding the cross-sterility of species and the cross-fertility of varieties. It consists in the direct and successful challenge of the older view. The evolutionist may admit that he knows as yet no case where domestic varieties are sterile when crossed. The reason is that fertility has usually been definitely selected as a characteristic by breeders, and it is most probable that if they deliberately set to work to produce infertility

¹ e.g. A. Dendy, *Outlines of Evolutionary Biology*, R. S. Lull, *Organic Evolution*, J. Arthur Thomson, *The Outline of Science*

between varieties they could achieve it. On the other and, the evolutionist can unhesitatingly assert that the species, natural and domesticated, are not always sterile when crossed, not indeed in rare examples, but on such a scale as to suggest that the old criterion of cross-sterility is practically worthless. It has in short been demonstrated, not indeed that all species are mutable, but that they are not all immutable, until the realisation has grown of how hardly we may reach a justifiable conception of a species. The modern conception seems vague and indefinite compared with the clean-cut pre-Darwinian view, indeed, a leading Neo-Darwinian has proposed that the term should be dropped altogether as corresponding to nothing in reality¹. A species is simply a group of organic forms that are more like one another than they are like anything else, that ordinarily interbreed, and that might be thought of as having a near community of ancestry. It is, however, the individuals that are real, rather than the species, the latter is but a relative conception, embracing a number of forms that show certain well-marked characters with a noticeable though not absolute consistency from one generation to another. This does not mean that there are no differences between species and varieties. As a general rule the former show much greater structural differences than the latter, and are in a marked degree more stable, none the less it is impossible to draw any hard and fast line between them. Alike amongst living and fossil forms, species are usually distinct and without intermediate links, but on the other hand there are classes, *e.g.* Foraminifera and Sponges, where the conception is practically valueless, so minute are the gradations between the various groups. Hence we have come to think of a species not as a sharply delineated group of living forms, but as an "abstract central point around which a group of variations oscillate",² where we see the peripheral

¹ Sir E. Ray Lankester, see Prof. E. B. Poulton, *Essays on Evolution*, p. 62.

² Prof. Charles Mitchell art. "Evolution," *Encyc. Brit.*, 11th edit., 11 x p. 35.

oscillations of one species overlapping those of an allied species we are tempted to look for transmutation.

Of the other proofs, that one which deals with the individual aspect of organic history offers perhaps the most striking contributions to the elucidation of the problem. It is to the effect that every animal briefly rehearses episodes out of the story of its ancestral history upon the stage of its individual history—"climbs its own genealogical tree," as Milnes Marshall vividly phrased it. If it be the case that throughout organic history the progeny of any individual has never commenced life at that stage where the parent form left off, and that its own history represents either a slight advance on the parental history or a failure to attain that stage, then the Recapitulation Theory simply must be true in some form. More strictly it implies that individuals of the higher forms of life pass in the course of their embryonic development through stages representative in a general way of ancestral forms in the line of descent. The recapitulation is never precise, it is in no sense a detailed rehearsal. Stages are often skipped and short cuts discovered, other forms show obscuring characters that are secondary adaptations to modes of life of which their ancestors had probably no experience. Nevertheless, in this suggested theory of these resemblances we have an historical interpretation of great value that is applicable in the case of mental and moral characters with as surprising results as in the case of those that are purely physical.

The Basis of Natural Selection

Of those factors whose resultant is Evolution it is convenient to mention in the first place Natural Selection, the distinctively Darwinian factor, whose value has been emphasised by Neo-Darwinians in a manner that quite out-Darwins Darwin. The idea was suggested both to Charles Darwin and A. R. Wallace by the study of Malthus' *Essay on the Principle of Population* (1798), in which, as the result of inquiries into what actually took place in certain districts of America, that

amiable country clergyman maintained that while the population increased in a geometrical ratio, the increase of food supply was only on an arithmetical ratio, a condition of things which would in a limited world eventually result in a struggle for existence. Transferred to the plant and animal kingdoms, the idea developed into the distinctive Darwinian assertions 1, (fact) that by reproduction the number of individuals tends to increase in a geometrical progression, and as the food and place for these are limited, (inference) there necessarily follows a struggle for existence 2, (fact) the offspring usually exceed the parents in number—in the majority of instances to an enormous degree—and yet there is no increase evident in the total sum of living organisms, (inference) accordingly, on the average as many plants and animals die every year as are born 3, (fact) further, the offspring whether of one or two parents or of a generation all differ from one another in varying degree of form or function, and (inference) in this struggle for existence those individuals whose variations are of such a nature as to give them some advantage over their neighbours will survive, and, leaving offspring, transmit to the next generation the advantageous characters that had survival value. This continual transmission of fortunate genetic variations results at once in modification of species and in that marvellous internal and external adaptation that constitutes so much of the wonder of Nature. The phrase Natural Selection as descriptive of the process is, however, incomplete and to that extent misleading. It is incomplete in so far as it expresses only one half of the truth. Natural Selection might just as well be called Natural Rejection. Darwin's phrase emphasises only the positive affirmative aspect of the process. The other aspect, the destruction of the unfit, is possibly the broader and in that degree the more important. It is in this sense that the word Selection is especially misleading. Strictly, as H. W. Conn insists,¹ there is no selecting, no selector. Nature does not so much select the best, as eliminate the worst.

¹ *The Method of Evolution*, p. 70

Of the enormous increase of organisms in geometrical ratio, many interesting statistics have been collected. Taking one general example and assenting to the reasonable proposition that there are one hundred trillion flies in the world to-day, we would find that, could they all be destroyed instantaneously, yet in three months one pair would have produced as many. Should each fly have the most favourable environment, no one could escape the plague of flies, no miracle would be so simple, only it would not be miraculous. Yet we do not notice any marked increase in flies or any of the myriad forms of life, about which the same statements could be proportionately hazarded. Intra-specifically as in the case of the members of an ant community, inter-specifically as in the feudatory relations of carnivore and herbivore, as also with the various forces of inorganic Nature, each individual wages a threefold warfare, not necessarily continuous,¹ yet of sufficient severity, particularly in the early stages of the individual life,² to maintain the species at an average strength. Under this pressure any slight modification in structure or function that gives an advantage to an individual may ensure its survival, on the other hand, in many cases no degree of modification whatever will avail for the survival of the harassed species. There is no absolute rigidity of action under Natural Selection, yet on the whole as the result of the struggle for existence it is the fitter organisms that win, in the biological implication of surviving to leave offspring. That the powers of reproduction seem to exceed the need of the species is simply due to the fact that it is this very prodigality of life alone that has made evolution possible. It ensures that competition without which there could be no differentiation and so no advance. Forms that did not develop this power of excessive reproduction must speedily have been out-distanced by forms advanc-

¹ It is also further lessened by the divergence of species into unoccupied localities, where the pressure is consequently not so severe.

² With certain modifications, these statements hold also for the human species. About 48 per cent of the population of England die before the age of 25.

ing by Selection, and were eventually exterminated. Of the sole sufficiency of Natural Selection in the mechanisation of Evolution a large and important school is fully convinced. Yet it can act only on prepared material, so to speak, and after a certain point it is entirely dependent on a supply of variations with whose origin it has nothing to do except in so far as it may be said to determine which individuals—the media of variations—shall give rise to other individuals. More particularly its insufficiency has been urged in such connections as accounting for the formation of paired organs and incipient new organs, or indifferent and seemingly useless specific characters of form,¹ size, and colour, as also in explanation of complete degeneration, or the appearance at the right time of those many variations that comprise specifications of qualitative and co-adaptive character. There is no question that the fact of mutation and the principle of correlation help considerably in lightening the burden that Natural Selection is made to carry. On the other hand nothing is more remarkable than the way in which Darwin, while holding as long as possible to Natural Selection, yet finally turned to the Lamarckian factors² to help him round a difficult corner,³ or the candour with which he admitted that serious difficulties stood in the way of Natural Selection. Thus his theory of Pangenesis was a distinct attempt to formulate a possible basis for the inherited effects of use and disuse. He saw clearly that degeneration or complete reduction in an organ or parts could not be explained by Natural Selection. Weismann saw this also, but provided an epicycle in his theory of Panmixia, which simply means that when an organ or quality is developed by Natural Selection, then that agency is necessary for the maintenance of the specific condition. If Natural Selection ceases to act, in the resulting promiscuous breeding the quality is no longer selected and gradually drops out of sight.

¹ Cf. Arthur Dendy, *Outlines of Evolutionary Biology*, p. 421.

² The principle of use and disuse, and the direct action of the environment.

³ *Origin of Species* (new impression), pp. 656, 657.

amidst the countless other competing variations Weismann, however, admitted the practical impossibility of explaining complete effacement in this way, and enunciated a further theory of Germinal Selection,—which was also a confession of the failure of Natural Selection to offer any account of the coincident appearances of necessary variations in many forms It is an attempted explanation of control, as it were, of the origin of fit variations But even here it is not difficult to multiply objections, and, in any case, Germinal Selection is pure hypothesis In fact, Darwinism is as Ptolemaicism and needs the introduction of subsidiary cycles and epicycles to make the explanation cover all the facts Which simply means that it is incomplete, if not positively faulty the Copernicus of Biology has not yet arisen

Ethical Aspects of the Struggle for Existence

In many minds there is associated with the term "struggle for existence" a grim, relentless, cruel combat waged by man and beast alike although in different ways, from which death alone grants a merciful release So far as the term is applied to human campaigns against zymotic disease, alcoholism, or even to war itself, it is a legitimate application of the biological idea On the other hand, to use the term in connection with the modern struggle towards a higher plane of existence, material or social, is, as Conn points out,¹ simply a misapplication For the idea which lies at the basis of Natural Selection as a factor in Evolution is that of a struggle in which the unsuccessful are actually eliminated and so fail to reproduce their kind Now, amongst civilised races, except under rare conditions, the struggle for food is seldom such as to affect man's reproductive efficiency, still less does it involve elimination Indeed, it is rather a matter of regret to modern masters of eugenics that our humblest orders, presumably those most near starvation-point, are so prolific The struggle in the case of man is severe enough without having the conditions obscured by secondary

¹ *Op cit* p 57 *et seq*

and comparatively unimportant applications, yet that conflict is waged with hopefulness as man by his intelligence progressively turns the edge of Natural Selection

In the case of the lower creation the impression is not so immediately hopeful. Poet and man of science alike have indicted Nature, and the charge of cruelty and unmorality seems to cut deep

"The Mayfly is torn by the swallow, the sparrow spear'd by the
shrike,
And the whole little wood where I sit is a world of plunder and
prey" ¹

Huxley also permitted himself to write of "the myriads of generations of herbivorous animals" which have lived "during the millions of years of the earth's duration and have all that time been tormented and devoured by carnivores", of carnivores and herbivores alike "subject to all the miseries incidental to old age, disease, and over-multiplication", and of "the more or less enduring suffering which is the meed of both vanquished and victor". And he concluded that, since thousands of times a minute, were our ears sharp enough, we should hear sighs and groans of pain like those that Dante heard by the gate of Hell, the world cannot be administered by what we understand as benevolence ²

The difficulty in reaching a correct estimate of the conditions of Nature has been increased by the vogue of a type of literature ³ which would persuade us into believing that many wild animals lead lives on planes of intelligence and happiness scarcely attained by humanity. The truth as usual is probably somewhere between, and larger than the pessimist's or optimist's purview, the one is as dangerous an individual as the other. To pronounce satisfactorily upon the ethical aspect of the struggle for existence it would be necessary to know all the facts, or at least to try and do so, as also to

¹ Lord Tennyson's *Maud*, Part I

² *Evolution and Ethics and other Essays*, pp 198, 200

³ e.g. Ernest Seton Thompson's *Wild Animals I have known*, Jack London's *The Call of the Wild*

guard against anthropomorphism when studying the face of Nature. Into any such judgment four distinct, unrelated, and in some degree paradoxical, considerations would need to enter.

I. The comparative study of the nervous system in the animal kingdom seems to show a varying capacity for pain which in the highest animals even is very different from the capacity in savage man and, as we descend the animal scale, the capacity lessens. What is pain in terms of physiology? It is the peculiar sensation experienced by the brain as a result of injury to, or affections of, the sensory portion of the nervous system. Hence, if the sensation of pain is ultimately referable to the brain, it seems a fair inference that the intensity of the sensation—the capacity for it—will be dependent on the degree of organisation of that organ and of the nervous system associated with it.

It is not proposed to make any detailed comparative examination of the nervous system, but rather to state a few facts which will serve to indicate the strength as also the limitations of this particular consideration. If we commence with the Protozoa, we find in their case a diffuse sensitiveness to external influences, but in the absence of anything corresponding to a nervous system we cannot suppose for a moment that they feel pain. So far as the most recent accounts indicate, the nervous system of the great group of Coelenterata, apart from certain sense organs, consists of a "nerve-net" which is less sensitive than these organs, and "only rarely open to stimulation from the environment"¹, the effects produced are on a par with those resulting from the flicking of a mimosa leaf. There are no sensory nerves to conduct the sensation of pain, no brain to become aware of it. In fact, detailed investigation of the invertebrate kingdom would show that pain, as human beings are sensible of it, must be relatively unknown there. Says one close observer, "When a crab will calmly continue its meal upon a smaller crab, while being itself leisurely devoured by a larger and stronger, when a lobster will voluntarily and spontaneously divest itself

¹ G. H. Parker, *The Elementary Nervous System*, p. 114.

of its great claws if a heavy gun be fired over the water in which it is lying, when a dragon-fly will devour fly after fly, immediately after its abdomen has been torn from the rest of its body, and a wasp sip syrup with evident zest while labouring—I will not say suffering—under a similar mutilation it is quite clear that pain, at any rate among the crustaceans and the insects, must practically be almost or altogether unknown”¹

When we reach the Vertebrates, we soon begin to get into difficulties, interpreting *e.g.* the wriggling of the landed trout as writhing, and tending to forget the accumulated evidence that serves to indicate that even severe laceration in the region of the mouth causes fish little inconvenience. Amongst reptiles, especially lizards, the instinct of self-mutilation in the caudal region is not uncommon, betokening a low grade of nervous development, and birds with their horny beaks, their scaly legs and feathered bodies are at any rate not so exposed to the possibility of pain through contact, as creatures more or less highly organised than they are. To this there probably corresponds a low pain-susceptibility.

When we come to the great class of the Mammals, the question presents itself to us in another form, and we find ourselves looking for some standard by which we can compare their sensitivity and ours. What we want to know is whether we are justified in imagining, in the case of a creature showing what seems to us undoubted signs of suffering, that the pain it endures is comparable to that which human beings would feel under similar circumstances. If we confine ourselves for the moment to the human species we find considerations that largely answer the whole question for us. For we have only to think a moment to realise that the pain consequent on the same injury to two men is by no means equal in intensity. This is strictly true of physical injury, but it also holds of moral suffering, and if this fact were realised our whole penal system would

¹ Rev Theodore Wood, F.E.S., art “The Apparent Cruelty of Nature,” *Journal of Transactions of the Victoria Institute*, vol. xxv. p. 257

be altered In the human subject the capacity for appreciating pain is to a marked extent a matter of temperament as also of civilisation Every one has gathered from his general reading that pain to the savage and pain to the civilised man are two quite different things One may, *e g*, refer to the rites by which the young "braves" of various Indian tribes were initiated into the full privileges of manhood, or to the story of Livingstone's bearer with the broken thigh As the result of large experience in operative work, Dr Felkin calculated that the relative susceptibility to pain in the European, the Arab, and Negro is in the proportion of three, two, and one He also noticed that in the case of the negroes the result of education was to increase their susceptibility to pain by one-third¹ We can see this same thing ourselves any day We know that an injury that would prostrate a brain-worker would be received with comparative indifference by a hand-labourer Education is higher-grade civilisation It results in brain development, and this reacts upon the whole nervous system, inducing a far greater susceptibility to pain than would otherwise have been the case As a general rule, highly educated men and women are the most susceptible to bodily suffering Along with hard mental exercise is developed *pari passu* increased sensitiveness of nervous organisation, it is the price paid for a brain That is to say, susceptibility to pain reaches a maximum in the case of those who have the greatest capacity of mental power the power to do and to enjoy varies directly as the power to suffer They are all indices of high development

In relation to the alleged cruelty of the struggle, many additional data have been collected tending to show that insensibility to pain attends the most characteristic methods of feral warfare and execution Soldiers in battle have often been unaware of serious wounds until weakened by loss of blood, and the temporarily benumbing quality of the feline blow has been attested again and again The wild beast looks not before or after in contemplation of impending

¹ Quoted by Rev Theodore Wood, *op cit* p 263

doom its life is entirely in the present There is nothing save sympathetic misinterpretation to suggest that animals live lives of continual alarm and maddened endeavour to escape the death that is never far from them and inevitable at last It is impossible to believe that any species could have thriven in its surroundings—could have survived as fittest and left offspring—if such had been the actual conscious conditions of their life Would life be worth living for the sparrow—could it exist—if it was in hourly fear of the sparrow-hawk? We see its seemingly terrified attitude on the approach of the racial enemy, but no more is involved in its instinctive response to the signs of danger than in the shutting of our eyelids to protect the eye The sparrow does not think a danger past is an incident done with Amongst the elements that have gone to compose survival-fitness there has been included an automatic response to specific signs of danger, as also an increasing capacity for suffering, which therefore on the Darwinian hypothesis, if not good, must be at any rate useful Nor is it easy to see how the pain or misery that is presumably the meed of the unfit or disappearing race can actually affect the individual comfort We have never been asked to suppose that the lives of individuals in a disappearing race, *e g* Red Indians, are on that account less pleasurable than the lives of individuals in an increasing race What we observe is an excess of deaths over births in the long run, owing to particular circumstances, not necessarily pain-inflicting—an unconscious process of extinction

In an extremely interesting study,¹ E K Robinson has attempted to get at the root of our misinterpretation of animal life, and raises the question whether there is not a difference between mental consciousness and bodily sensation He quotes with effect certain lines from "That Day," in which Rudyard Kipling describes one of those sudden panics into which even the British soldier may fall

"Till I 'eard a beggar squealin' out for quarter as 'e ran,
An' I thought I knew the voice an'—it was me!"

¹ *The Religion of Nature*

Here is graphically pictured the momentary dislocation, as it were, of the purely animal unconscious instinct and the governing and controlling consciousness in the fugitive soldier, and the suggestion offered is that all the experiences of the lower creation are of the former type. If the soldier had been speared through the heart before he realised that it was his own voice which he heard, he would have died without consciousness of the anguish of fear. "I didn't know what I was doing," we sometimes say of moments of crisis when we act instinctively. So do the lower animals live and die a mesmerised kind of a life, unconscious in any human degree of bodily agony that they may seem to be suffering. That is to say, although to all appearance animals may be suffering pain, yet it does not necessarily follow that they do so consciously. Or in Robinson's most extreme statement¹—"We all think in words, and there are no ready-made words in which we can think of animals feeling pain without being conscious of it." The animal continually acts, as we sometimes do, "on the spur of the moment," but does not appear to reflect subsequently upon such action. The sheep in the park rushes in evident headlong terror from the dog, but when the latter is called off, immediately it puts down its head and quietly resumes feeding. The animal "acts before it thinks," only it does not think. Man usually thinks before he acts, yet occasionally he instinctively reverses the order. He chooses his line of conduct. Nature has chosen it for the lower creation by the elimination of all courses save the right one. Accordingly we imagine that the animals have chosen because they do what often seems to us right, and most often very wonderful. What we really see is, rather, evidence of something kin to our own minds expressed in this external direction of their lives.

II Examination of the conditions of organic progress shows that it has always been the outcome of a certain saving discontent. Progress follows acute organic dissatisfaction. It is the result of constant experimentation

¹ *Op cit* p 16

in the individual life Nothing in this world of things organic or inorganic is perfect, although much is becoming perfect The adaptation to environment is never perfect in any case Perfect physical conformity, complete adaptation, would mean eventual death As the conditions change it is necessary that there be change in the adaptation—that way alone survival lies—but perfect adaptation would involve complete surrender to a definite environmental phase, and such extreme specialisation carries with it exhaustion of adaptability Probably the nearest approach to perfect adaptation is to be found in the case of some parasites, but that means eventually degeneration, stagnation, death If we consider any period of organic history we shall find that its dominant forms, so far as freedom from danger and discomfort is concerned, were forms ultimately doomed to degeneration or stagnation¹ Every progressive race has had to choose between the present and the future, and in so far as it elected the present it surrendered the future The type that will hold the future has not completely conformed to the present it has exercised a certain non-committal aloofness to the present To a definite extent conformity is necessary, indeed is a condition of survival, but it is not in itself a guarantee of progress Consider the days of molluscan glory and the almost perfect adaptation of the oyster Protected within its shell which hindered locomotion and reduced nervous intercourse to a minimum, living in the midst of plenty and like a true worldling occasionally doing a pretty thing as it healed its hurt with a pearl, its life was for the present—a rich and easy life, reproducing its kind in legions And in the same waters were aspiring, struggling forms, ancestral to true vertebrates, feeble in size compared with *Orthoceras*, scantily protected as measured by Crustacean armament, and yet the day was to be theirs Or, if seated on some point of vantage in Jurassic days an observer had been asked to choose from out its rich

¹ This point and subsequent illustrations have been directly suggested by J M Tyler's *The Whence and the Whither of Man* (1899), p 194 *et seq*

and varied fauna the form that would survive, would he have passed over the various groups of powerful saurians and given the verdict to the little marsupial mammal diligently striving to avoid becoming a saurian meal? Its very inability to contend in brute strength drove it into brain-building. At every stage the same story may be read. It is not a parable, it is a transcript of all phylogeny. A long-range view of organic history shows that ultimately the race has never gone to the swift nor the battle to the strong. There is no form of life that has not at some period been in that narrow upward way towards a higher type of life that rises to the very end, but they have almost all gone out of it. "Say not the struggle nought availeth" from the evolutionary point of view it avails everything.

III No account of the struggle for existence can pretend to be complete which fails to take notice of the mutual service or self-sacrifice that enter into it so objectively. The recognition of the existence of such a factor as Altruism must inevitably modify our conception of the character of the evolutionary process very profoundly. Geddes and Thomson had pointed out the reasonableness of recognising in animal life "the co-existence of twin streams of egoism and altruism, which often merge for a space without losing their distinctness, and are traceable to a common origin in the simplest forms of life" ¹ and Herbert Spencer had previously stated "that without gratis benefits to offspring, and earned benefits to adults, life could not have continued. By virtue of them (altruistic principles) life has gradually evolved into higher forms" ² Prince Kropotkin also, in articles on "Mutual Aid among Animals," had drawn attention to the factor ³ But it was Henry Drummond ⁴ who first gave a really detailed account of it, showing the gradual domination of the self-regarding activities, based on the function of nutrition, by the other-regarding activity grounded in the

¹ *Evolution of Sex* p 279 ² *Principles of Ethics*, vol II p 5

³ *Nineteenth Century*, Sept and Nov 1890 later incorporated in *Mutual Aid a Factor in Evolution*

⁴ *The Ascent of Man*, chap VII

function of reproduction "Sympathy, tenderness, unselfishness and the long list of virtues which make up Altruism are the direct outcome and essential accompaniment of the reproductive process For a time in the life-history of every higher animal the direct, personal, gratuitous, unrewarded help of another creature is a condition of existence"¹ Accordingly it is not suggested, nor did Drummond pretend, that he first called attention to the existence of this factor He was not the discoverer of this "stream of altruism," but he first made a systematic exploration of it If, in tracking the stream to its source, he sometimes fancied he found it trickling where it did not actually exist, or marked its course as open where in reality it was still flowing underground, we may pardon the errors of an enthusiastic explorer But he did more, for he followed the stream in the opposite direction, and maintained not only that at a certain point it united with the other, but that the turbid waters of the stream of egoism were being lost in the clear flowing tide of altruism In the chapter referred to he traces a certain altruism throughout the brute creation, and tries to show that the evolution of animal life, while not in itself necessarily moral, might still have been preparing the way for morality in man

This altruism expresses itself in various ways Indirectly the principle is operative in countless favourable interrelations between animal and animal or animal and plant that have as result an increase in the sum of life, as also in those different aspects of gregariousness that represent more effective ways of carrying on the struggle More directly it is manifested in that care of the young and willingness to surrender life for them that have proved far more effective elements in racial progress than the sharpest tooth or keenest eye Altruism has paid its way from the beginning, bounty-fed by the more abundant life that has followed in its wake, expansive in virtue of the very limitations it imposes Pure selfishness, isolating and improvident, may, by reason of its complete conformity to the present, acquire a temporary dominance, but it

¹ *Op cit* p 186

has no hold upon the future, and is its own destruction. Co-operation, then, in its various phases, in fact all the various relations and favourable interactions that organisms adopt whereby life more abundantly is produced and as a result higher life is evolved, have definitely to be recognised in any account of life, as without them it would have ceased. Self-sacrifice, conscious or unconscious, is a condition of continued life, all the specific adjustments of creatures are ultimately there for generations unborn.

Now, while reflection on this altruistic factor suggests certain correspondences with moral teaching and practice, it is not just so easy to see the higher justification of the self-regarding activities. If altruism be held to be the sum and substance of morality, this difficulty must always remain. On the other hand, it must be urged that altruism does not exhaust morality—that self-preservation, self-assertion, self-perfection are just as important and as necessary to ethics as self-surrender, self-abnegation, self-sacrifice. In that event it is possible to find the counterpart of the natural self-regarding struggle in the higher sphere of the spirit. For self-love in its noblest sense is just as much a duty as to show love to our neighbours. Life, after all, resolves itself for us into the play—the action and interaction—between the organism and its environment, human or physical. Unless a man sees to his personal development, he will have nothing to give to others. Life is a perpetual giving and receiving. He who has nothing to give is dead, he lives most who gives the most and the best. And as a man dare not rightly give to others that which involves moral loss or harm to himself, so for the very sake of others he is bound to make the most of himself. The altruistic motto is, “Thou shalt love thy neighbour.” The individualistic motto is, “Thou shalt love thyself.” The incomparable Christian motto is a choice blend of these two words, “Thou shalt love thy neighbour as thyself.” Here we have law not merely rational but Divine.

That this altruistic factor is likely to exert an increasing influence would seem to be clear if only from

the unsatisfactory condition of the present stage of human evolution. The causes for this condition lie in the exaggerated social inequalities, the extremely unequal distribution of property, the excessive individualism. The integration of the human race will only be brought about, as it has been brought about in humbler societies or colonies, by co-operation, by a determination not merely to live and let live, but to live and help live, by a public opinion which will control competition till its rivalry is never other than that healthy striving without which progress cannot be. In these directions human evolution is increasingly tending as the result of the inspiration and leading of those who have been most sensitive to the spiritual aspects of the environment.

IV When we have estimated the real worth of the charges of cruelty against Nature, have realised the price of progress, and considered the place of altruism, we may return to ponder the fundamental place of suffering and of service in the world. For they have been there from the beginning, curiously connected, no mere capricious incident, but part of the very pattern of the web of life. In a very real sense the successful species that occupy the great geological horizons have come out of great tribulation, "redeemed at a great price, even of a thousand species and tens of thousands of individuals, who fell short of the typical fitness and were killed out"¹. Every successful species was but a pioneer of progress, and sooner or later, "like the scouts of a great army, was caught in some physiological ambush" to its own undoing. And as Creation is an organic whole, every part is in the service of some other. The plant world is in the employ of the herbivorous section of the animal world, it does it service. But in the course of time appear the carnivorous groups, the herbivorous forms come into their employ, the altar of sacrifice is raised, and since that day its stones have never been cast down. Suffering and service are wrought into the process. Our more abundant human life is the outcome of the travail of creation's

¹ W. W. Peyton, *Contemporary Review*, October 1900

lower forms Whatever we have in national or social or individual life that is at all worth having has been purchased with the price of blood It is almost unnecessary to remark that the recognition of this suffering and service is no modern discovery The suffering at any rate has been recognised from the dawn of thought, and nothing is more pathetic reading than the hopeless solutions of the problem, whether offered by Greek, Buddhist, or ancient Hebrew To the latter suffering was punitive even in the most tender of the Psalms man's days were conceived as passed away "in God's wrath"¹ "Or those eighteen, upon whom the tower in Siloam fell and slew them, think ye that they were sinners above all men that dwelt in Jerusalem?"² asked Jesus, combating this essentially pagan view But to-day we realise the purpose of suffering in perfecting the adjustments of the lower creatures to the world around them, and in perfecting the adjustment of man, not merely to the world around him, but to that larger spiritual world that is at once within, around, and beyond him Or if we may not yet use teleological phrasing in our interpretation, we can at least say that life is adjustment, and that sacrifice and suffering are means for perfecting the adjustments of living things to the world around them, and, as so increasing the sum of life, are a good

And when in more mystic mood we consider this suffering and service in the light of the Crucifixion, they seem to glow with an added lustre Suffering itself is service, and vicarious suffering is its highest expression The principle of vicarious self-sacrifice pervades creation, and is most marvellously provocative of service in others At Calvary God in Christ draws men to Himself by His submission to this one great law of sacrifice Viewed in this light the misery and seeming waste associated with the struggle for existence are seen to be not wholly unconnected with the profoundest fact in history What we really have is age-long unconscious sacrifice for the good of others dimly foreshadowing the one great oblation There is a very real sense in which

¹ Ps xc 9

² Luke xiii 4

the survival of the fit is the survival of the obedient. The forms of life that have survived are those that adapted themselves to the demands of the environment, and progress has consisted in completer adaptation, increased specialisation, more perfect obedience. He was obedient unto death, even the death of the Cross ¹ therefore He lives. And so the darkest features of human suffering may undergo a strange illumination, and cease to seem the cruel, meaningless episodes that too easily they might become. The outer man is continually being sacrificed, but in the interests of the man within, or of other men without, or even, it may be, of the world beyond. The Crucifixion has taught us once for all that there is a service of love in suffering and tribulation, that out of death there springs life.

¹ Phil 11 8

CHAPTER VII

VARIATION

At the foundation of the Darwinian explanation of Evolution was the belief in the existence of fortuitous¹ variations occurring in every direction in every part of every organism, and continuous in the sense that all the gradations might be found between any two extremes. The members of a species, though resembling one another more closely than they do all other creatures, are yet not absolutely alike. No two oak trees are exactly similar: no two leaves on any tree are identical. The members of a species show differences that make themselves apparent even in the offspring of the same parents. It is the inexperienced eye which considers all sheep alike: far different is the shepherd's account. The trained observer can notice measurable differences in the Protozoa produced by fission, or in the numerous broods of parthenogenetic forms like *Daphnia*. It is these small though universal fluctuating differences that are referred to by the general name of variation, or better, variability, and to variability on the Darwinian theory is due the great diversity in the organic kingdom throughout all time. Without it there could have been no change for better or worse, neither ascent nor descent, neither evolutionary progress nor degeneration. If offspring had always resembled their progenitors, each generation would have been the facsimile

¹ Strictly this was hardly Darwin's own conception so far as actual phraseology is concerned. "I have hitherto sometimes spoken as if the variations were due to chance. This, of course is a wholly incorrect expression, but it serves to acknowledge plainly our ignorance of the cause of each particular variation" (*Origin of Species*, p. 164). Nevertheless the general impression, as made upon his generation, is not incorrectly described as above.

of the last, and a man and his grandfather would not have represented such extreme terms of a series as they do under present conditions. If all this is true, it is only by a study of variability that we may hope to understand the method of Evolution. Variations are the material furnished to Natural Selection—some of them as advantageous are preserved, for the essence of the principle of the survival of the fittest is utility. The happy possessors become the parents of the next generation, the fortunate character is transmitted, it was supposed, and tends to be intensified.

Although there are no absolute distinctions, variations can be usefully grouped according to the character of their source and origin, or according as they show quantitative or qualitative change. From the former point of view we may distinguish, first, those inborn variations that apparently have no relation to external conditions—they are inherent in the constitution of the individual, and inherited by it. In origin they are abintral—they develop under the stimulus of nutriment. We shall refer to them as genetic variations. There are also those changes, more or less adaptive, that are caused by the direct action of external conditions, that are the result of use and disuse, or arise as the effect of something environmental—climate, injury, or the like. They are incidental and abextral on the whole, being developed under the stimulus *e g* of use or injury, and constitute the so-called “acquired characters.” The term “acquired character” is, however, somewhat misleading. It expresses no absolute distinction. All characters, even those that are genetic, must have been acquired at some time or another—in the case of the unicellular form the distinction reaches the vanishing point. We shall therefore speak of them as modifications. From another point of view variations may be regarded as continuous or discontinuous, quantitative or qualitative. The former group will include that type of small fluctuating variation of which any gradation between two extremes will ordinarily be found if only a sufficient number of cases is sought and examined. The discontinuous variation, on the

other hand, is sharply marked off from the other members of the group, and differs so markedly that the change may be described in most cases as qualitative

For a time there was much statistical study of the quantitative fluctuating variations, since it was an early Darwinian difficulty how such minute continuous fluctuations, occurring admittedly sometimes in but a few cases, perhaps in one, could involve a utility that determined life or death, or, if they did, could avoid being swamped by cross-breeding with the parent stock. It was found that they are abundant, and may affect any part or any character—even the habits—of an organism. They occur in domesticated forms and are probably equally developed in feral life. Occasionally they attain considerable magnitude, sometimes as much as 25 per cent with gradations. Further, they are all capable of being grouped about a mean, but while in some cases the most frequent measurement or condition (technically called the mode) may be found to correspond to the mean¹ or average value for the character, in most cases it is found that under changing conditions there is not a marked grouping of individuals on the mean. On the contrary, they rather tend to heap up on one side or the other of the mean, with the result that, very roughly, half of the individuals are above the mean and half below it in respect of any definite character. Often the disproportion between the two groups is more marked, and the curve of their distribution may even show two widely separated modes (dimorphism), but in any case one or other of these groups will ordinarily possess the advantageous quality and will survive. That is to say, the facts of variation as they are known amongst animals seem to indicate advance upon the principle of averages rather than by any selection of individual variations however useful. Only such continuous variations as simultaneously occur in many individuals could therefore have much influence upon the race. The variation need not be

¹ Take, *e.g.*, four men with heights of 70, 72, 72, 74 the mode is 72 and corresponds to the mean. But take four men with heights of 68, 70, 70, 76 the mode here is 70, but the mean is 71.

obtrusively useful in order that it shall come within the reach of Natural Selection, if only it be such as can vary around a mean, and ultimately be correlated with some more important character or favourably influence the production of offspring. Small fluctuating variations could be used to give increase in any definite direction within certain limits, if the struggle for existence is keen enough to make that amount of variation of selective value, and that direction will be linear only.

A theoretical illustration may serve to make this principle of variation clearer¹. Suppose, for example, that owing to the deeper burrowing in trees of insect larvæ it becomes advantageous to a race of woodpeckers to have a more elongated tongue. It is probable that any single variation producing a long tongue would have little or no influence upon the species. But the statistical study of fluctuating variations tends to suggest that most of the birds of a species have tongues either longer or shorter than the average. If three-fifths of the birds must perish during some period of famine, it is clear that the two-fifths that succeed in living will be sure to contain more long-tongued birds than short-tongued ones. Now, these birds will mate with one another, and thus there would be no opportunity for the new character of longer tongues to be swamped by cross-breeding. In short, it has definitely been found that normal variations present many simultaneous variations in the same direction. As a result the next generation will have a tongue whose average length is longer than the average of the last generation. Evolution thus acts upon average groups rather than upon individual variations. "advance is an advance of a species *en masse* and not by isolated spurts"². Individual variations count for little; variations above or below a mean count for much. Such an advance by general averages will eventually reach a state of equilibrium. The tongue of the bird will not continue to lengthen indefinitely, because a point will be reached beyond which any increase in length would be dis-

¹ Cf H. W. Conn *The Method of Evolution*, p. 111.

² Conn, *op cit* p. 112.

advantageous With the lengthened tongue there presumably may be correlated a corresponding lengthening of the beak, and under normal conditions a certain average character of the organs will be maintained Should the conditions undergo change, another average length might be better fitted for the struggle, and under Natural Selection, through variations in that direction, the new mean would be evolved

The above instance is theoretical, but sometimes it is possible to check such theory by observations in Nature Such a chance had Professor H C Bumpus in the case of the (introduced) English sparrow (*Passer domesticus*)¹ One hundred and thirty-six of these were collected in a state of exhaustion after "an uncommonly severe storm of snow, rain, and sleet" in North America (Feb 1, 1898) seventy-two revived, the remainder perished Bumpus made a series of careful comparisons between the survivors and their less fortunate kin and noted very appreciable morphological differences It is not improbable that the more important causes of survival or the reverse were physiological rather than morphological, but we may consider the results attained Without going into the actual figures, it may be stated that while the average characters differed but little (and the characters investigated were total length, alar length, weight, length of beak and head, etc), the variability of the eliminated birds about their mean was much greater than that of the survivors The very long individuals, for example, suffered heavily in the struggle, as of the thirty males obtained in which the total length was 163 mm and upwards, no less than twenty perished likewise the two shortest male birds perished Bumpus's general conclusion was that "Natural Selection is most destructive of those birds which have departed most from the ideal type, and its activity raises the general standard of excellence by favouring those birds which approach the structural ideal" Of this ideal, of course, he could give us no information, and further the number of cases observed was very small, but if all the sparrows in that region had been affected by the storm, and he

¹ *Biological Lectures*, Wood s Holl, 1898, p 211

ould have extended the results obtained in the 1360 to them all, it would probably have appeared that the next generation of birds collected in that storm-swept area would have been shorter in length, of less weight, had longer legs, wing bones and breast bone, and a greater brain capacity than their predecessors

But, now, to realise that a certain variation appears simultaneously in many individuals is to surrender the idea of pure fortuity and to make the variations so appearing determinate. To do this, however, is to give up Natural Selection as the basal cause of Evolution. For if variations are in this or in any measure determinate, then their direction is determined by some prior factor, and the vital factor in Evolution is not Selection, but that which determines the character and the timely appearance of these variations that shall prove to have selective value. All that Natural Selection does is a sort of police work, keeping the species moving in the thoroughfare and destroying those that wander out of it.

Accordingly this realisation of the fact of determinate variation—this tendency on the part of many individuals to vary simultaneously in a similar definite direction—is of great importance in the interpretation of Evolution. Some of the evidence relating to discontinuous variations is very suggestive in this connection, as we shall see. Darwin himself admitted the existence of determinate variation, but several modern biologists believe that determinate evolution is the actual species-forming factor. Continually may be found in their writings the recognition of some factor—a “directive tendency,” “progressive tendencies,” or “inherent influence”—at work prior to selection, determining the character and appearance of variations. In short, the evidence for trends of modification in particular directions, for this tendency of variations to group themselves and be more numerous in certain directions than in others, becomes, where it is noticeable, singularly impressive. We may not be able to understand the cause and nature of the phenomenon, but there can be little doubt that it directly affects evolution. While it suggests that the direction

of variation and hence of selection is pre-determined in some way, either in the nature of the living form or in its relations to the environment or both, it, at any rate, makes it certain that variation cannot be regarded as occurring in every direction and fortuitous. Palæontologists in particular are strongly impressed with the fact that Evolution has proceeded along definite fixed lines. They find no suggestions of "miscellaneous trials," no hints of the myriad failures that the other point of view demands. W. B. Scott in several remarkable papers has stated this view very forcibly, showing that the horse in its evolution has moved unswervingly towards a predetermined goal—the mean at any rate moves in a determinate direction. He finds it impossible to see how the definite progression in the teeth can be explained by Natural Selection—the little pin-points of difference cannot have been what determined the life or death of the species. Every stage is represented, and the evolution is direct and definite—at least it gives that appearance. He has well compared the line of this definite advance to the "track of a cyclonic storm (which) is determined by the path of the storm centre, around which the winds circulate, blowing in every direction. These circulating winds would represent the variations which occur at every stage in the history of a phylum, while the course of the storm centre would represent the phylogenetic change or mutations¹. Thus the cycles of variation tend to repeat themselves, though the centre around which they revolve has a course of its own, dependent, not on the accumulation of these winds which happen to be blowing in the right direction, but upon factors of a much wider significance."²

But the origin of species was also supposed to have been observed from considerable variations, which, as unconnected with others by gradational stages, and as involving very definite differences of sometimes considerable amplitude, are known as discontinuous variations (Bateson) or mutations (de Vries). The theoretical

¹ i. e. in Waagen's sense of steady advance along certain definite lines

² *American Journal of Science*, vol. XLVIII p. 373

interest in such occurrences has been great, for if substantiated they would remove another of the old weighty objections to the Darwinian account. For it was always a difficulty to see how the first stages, say in the formation of a new organ, or even of an instinct—the initial minute variation or expression of a character that ultimately in a more developed state was found to have survival-value—could be of such life-and-death value as to ensure its survival. Further, would it not probably be swamped by interbreeding with the common stock? A partial, though incomplete, answer was offered in the principle of correlation, and in the established fact that organs have often changed in character and function,¹ and that possibly the different stages might each have been useful for a different purpose. Now, if such characters—and this applies to instincts and habits as well—arise in a more pronounced form, in a degree sufficiently developed to give Natural Selection a handle, so to speak, and are found to breed true through successive generations, this difficulty would vanish. Or again, how, by the action of Natural Selection on a series of minute and almost imperceptible variations, could there arise a number of different structures or parts so co-ordinated as to share in a common function? This might occur as a mutation. As sports and monstrosities, certain extreme variations had long been recognised and known. Darwin himself listed several such sports,² and noted that certain species or races at least of domesticated animals and cultivated plants had their origin in this way, as *e.g.* the now extinct long-backed ancon sheep, with short crooked legs, descended from a single ram-lamb born in Massachusetts 1791 with these characters, and the merino ram-lamb raised on the Mauchamp farm in 1828, remarkable for its long, smooth, straight, and silky wool. What had not been realised was the possible frequency with which such a process might occur in Nature, the possibility that such sports of a less extreme character had *often* served as the initial points of new races, the possibility that,

¹ *e.g.* mammalian lung=swim-bladder of fish

² *Animals and Plants under Domestication*, vol 1 chap 3

as de Vries maintained,¹ "species have not arisen through gradual selection operating for hundreds or thousands of years, but by steps (*Stufenweise*), through sudden, though quite small, transformations" "I intend," he said,² "to give a review of the facts obtained from plants which go to prove the assertion, that species and varieties have originated by mutation, and are, at present, not known to originate in any other way"

Darwin's variations were all linear and quantitative and, said de Vries, in that way you can get nothing new—only increase or decrease in what is already there, dependent on the continuance of selection, but no qualitative change This, however, is not in itself a serious objection, for many specific characters are simply quantitative (*e g* smooth and hairy leaves), and many qualitative ones are ultimately quantitative Still, Galton's *Law of Regression*³ suggested that variations do not go on indefinitely in a linear series, but soon reach their limit, and that unless some new kind of variation arises, progress in one specific direction soon ceases This has been confirmed *e g* by Johannsen, with beans and barley bred in pure lines He notes that the tendency over a series of generations is for the average character, rather than any individual characteristics, to be reproduced He accordingly attributes the origin of new types either to the crossing of races or species (hybridisation), or to mutations

In seven generations extending over twelve years, Hugo de Vries⁴ succeeded in obtaining 834 mutations belonging to seven distinct types out of 53,500 plants of the Great Evening-primrose (*Oenothera lamarckiana*) of these some appeared in greater quantity than others "The main fact," he asserted, about the mutating species "is, that it does not change itself gradually, but remains unaffected during all succeeding generations It only throws off new forms, which are sharply contrasted with the parent, and which are from the very

¹ *Die Mutationstheorie*, 1901-1903, p 150

² *Species and Varieties*, p 9

³ Cf p 162

⁴ *Die Mutationstheorie* *Species and Varieties, Their Origin by Mutation* (1905)

2 SPIRITUAL INTERPRETATION OF NATURE

gunning as perfect and as constant, as narrowly fined, and as pure of type as might be expected of any species"¹ With a single exception all these types bred truly in spite of the fact that they differed from one another not merely in one, but in several characters. The parent plant held to its specific type all through, it might give rise again in this discontinuous manner to various kinds of new forms differing qualitatively from it, which were more or less fit to survive than the parent form, and if fit, remained true to their type. Transition forms were found, but their position was not near, they were not necessarily intermediate steps. They arose before, simultaneously with, or after, the new species. Here, then, was an origin of species very different from the Darwinian account.

The difference between the two theories is apparent from the strictly Darwinian point of view, the transformation of species was effected by the slow selection of favourable variations out of a mass of minute fortuitous fluctuations affecting usually a single character at first, later others by correlation or otherwise. This was the view shared by Wallace, it is also supported by Luther Burbank's cultural work. On the de Vriesian view, species originated suddenly, independently of the Darwinian variations, by the occasional appearance in definite discontinuous form of one or several considerable variations that differentiated the new species thus originated quite markedly from the old, and these new characteristics were definitely transmitted to succeeding generations. According to the Darwinian view, Evolution proceeded by a slowly winding pathway; according to de Vries, the movement was step by step, as it were up a staircase, in a definite direction.

If now we inquire to what extent it is definitely known that such mutations give rise to new species, the answer must be that the number of known origins of species or races from such mutations is disappointingly small—disappointing, that is, as in support of what de Vries claimed as the method of origin of all species. In the particular case of the evening-primrose, de Vries

¹ *Species and Varieties*, p. 28

observed twelve mutations in all MacDougal, experimenting with the same form in New York, obtained thirteen. The Shirley poppies, whose petals show a narrow border of white, arose as a mutation of the common wild field poppy, and a few other plant mutations are known. They are all, however—and even de Vries' *Oenothera* is probably no exception—phenomena of artificial cultivation, under which man has always selected forms showing striking differences, he has selected variability, and got it. In the animal kingdom even yet comparatively few instances are on record to be added to those collected by Darwin. Of species in a state of Nature, mutations have been described in the case of a few insects, and amongst medusæ and fresh-water fishes, but there is no evidence of these producing new races. Greater opportunities of observation are afforded by domesticated forms, and here, as Castle maintains, "the material used by breeders for the formation of new breeds consists almost exclusively of mutations. On the whole, it appears that the formation of new breeds begins with the discovery of an exceptional individual, or with the production of such an individual by means of cross-breeding. Such exceptional individuals are mutations"¹. Stock registers show, he states, that "the beginnings of new breeds are small". A herd of polled Hereford cattle descended from a calf born at Atchison, Kansas, in 1889, cases of generations of polydactyly in human beings, Kennel's stump-tailed cat and Castle's guinea-pig with a supernumerary fourth digit both giving rise through several generations to similar offspring, the series of some 400 mutants of the fruit-fly *Drosophila* so thoroughly worked out by T. H. Morgan and his co-workers, and Tower's mutant potato beetles (*Leptotarsa*) form the best authenticated elements of support for a theory that was supposed to be about to supplant the Darwinian conception of variation in its relation to the origin of species. Not, however, of Natural Selection. On this point de Vries was most explicit: "Notwithstanding all these apparently unsurmountable

¹ *Science*, vol. xxi pp. 522, 524

difficulties, Darwin discovered the great principle which rules the evolution of organisms. It is the principle of Natural Selection. It is the sifting out of all organisms of minor worth through the struggle for life. It is only a sieve, and not a force of Nature, no direct cause of improvement, as many of Darwin's adversaries, and unfortunately many of his followers also, have so often asserted. It is only a sieve, which decides which is to live, and what is to die." ¹

But an even more vital question is whether de Vries has formulated a truer account of the character of those variations upon which Natural Selection is admitted by him to work in the production of new species. The answer is in some respects doubtful. In the first place, while he demonstrated the broad difference between the inherited mutant and the non-inherited fluctuation, it is still open to dispute whether the distinction is as absolute as he maintained. Many mutations are comparatively stable, it does not follow that all are absolutely so. To base a theory of evolution on the fact that fluctuating variations are not fixed as the result of man's short experimentation with them, is to be blind to the possibilities in the patience of Nature, and to make an unwarrantable generalisation about all mutations on the strength of a couple of decades of experimental generations. In any case, mutation and fluctuating variation are alike expressions of a ceaseless metabolism, just as the constant, internal motion of a large electric clock may reveal itself either in the creeping continuous movement of the hour hand, or the leaping discontinuous movement of the minute hand. In the second place, its value is impaired by the peculiar de Vriesian conception of a species. "Pedigree-culture is the method required," he says, "and any form which remains constant and distinct from its allies in the garden is to be considered as an elementary species." Linnæus himself knew that in some cases all subdivisions of a species are of equal rank, together constituting the group called species. No one of them outranks the others. It is not a species with varieties, but a group consisting only

¹ *Species and Varieties*, p. 6

of varieties. A closer inquiry into the cases treated in this manner, by the great master of systematic science, shows that here his varieties were exactly what we now call elementary species."¹ De Vries believes that the mutation appearing in one or more individuals will through its permanence constitute eventually an elementary species. New species arise by the selection of the fittest elementary species rather than individuals. This involves a conception of species as sharply distinct from one another, which is not what meets the eyes of the taxonomist in the world of living things. It is the continuity that baffles there. In the third place, not only is the evidence for mutations in a state of Nature precariously small, but it is open to question whether de Vries himself, although laying such insistence on the necessity of thorough knowledge of pedigree, was right in his views of the origin and past history of his own experimental form. It has not been found wild in America, whence it was supposed to have come. Very probably it is a domesticated hybrid, produced by crossing various forms of the dimorphic *C. brennans*, which was definitely introduced into France from America in the eighteenth century. On the other hand, undoubted wild species of *E. nothera* have since been shown to behave in much the same way as *lamarckiana*, and throw off numerous new types. The most recent investigation tends to explain the phenomena as resulting in part from "differences in chromosome number due to irregularities in reduction or fertilisation."² The further difficulty of such undoubted hybrids continuing to produce new types is met by supposing that rearrangements of linked characters, due to an exchange of factors (genes) during the conjugation of chromosomes (synapsis),³ lead to the breaking down of a certain limited and inhibiting association amongst the factors, and so permits of the formation of mutants. Yet even this explanation in turn is only partial. While, then, it is of great importance to know that such mutations

¹ *Op cit* pp 12, 13

² Cf 1 H Morgan, *The Mechanism of Mendelian Heredity*, p 310

³ Cf Glossary and p 175

do occur, and that on occasion they may result in the origin of new races, possibly of new species, there is no warrant for the extension of such a mode of origin to all existing species. We still await an unequivocal instance of the origin of a species in a state of Nature from some discontinuous form or forms. Theoretically, quite apart from all demonstration, the idea of the mutation is, however, very helpful. Man certainly varies in almost every feature of his physical frame, and it is not improbable that the pigmy races of Central Africa had their origin in a mutation. Man himself may have originated from his anthropoid ancestor as a discontinuous variation. In fact, the discontinuous variation conforms to the correct conception of a "break" as outlined at an earlier point ¹

We have now learned a little about the manner of variation, but with regard to its actual cause we have made no progress, although it is obvious that in the solution of this problem the ultimate understanding of evolution lies. We have as yet no sufficient explanation of the origin of variations, or of that accumulation of them in definite directions that at a certain stage may acquire selective value because of their utility, although much has been learned about the nuclear (chromosomal) elements that correspond to them in some degree, and the mechanism of their arrangement and segregation ². In these pre-selective moments the secret is hid, but it is a secret shared with the Environment, which may perhaps by skilful interrogation be prevailed upon to surrender it. In any case it is difficult to see how a broadly progressive evolution can result from any mere endless recombination of already existing units, even under the stress of the Environment. Ultimately the units themselves have to be accounted for, and their origin must have something environmental about it, the only other alternative is, "creation out of nothing."

¹ Cf p 109

² Cf Chapter VIII

CHAPTER VIII

HEREDITY

HEREDITY is the link, the genetic relation, which binds one generation to another. It is the expression by which we designate that well-known and long-observed tendency of plants and animals to resemble their immediate progenitors. In popular phrase the truth has been enshrined for ages "Blood will tell," men say, suggesting that the past in some way determines the present. "the chip of the old block" is still the perpetual joy of his father's friends. Heredity is the great conservative factor in Evolution. It is the register alike of progress and regression. It is a perpetual guarantee against organic chaos and disorder. If there is something centrifugal, adventurous, and experimental in the widespread organic tendency to variation, there is that which is centripetal, steadying, and eminently contented in Heredity.

The outlook of Heredity is as broad as life, although there is just a chance that it is not as old as life. The earliest organisms, immensely variable, must have lived some time before a fund of heritable organic experience was collected. Viewed in its relation to man, Heredity provides the undertone of the Greek tragedian, the burden of the modern social reformer's cry of despair. It is that one of the Fates whom men think they know, into whose face they have looked and sometimes found a friend, more often recognised an enemy. As a scientific problem, it raises questions innumerable that touch man at every point of his complex being. To take but a single instance, that of the transmissibility of the modification or so-called acquired character—a question upon which even yet there is no final

consensus of judgment Here is a matter whose practical aspects far outweigh in importance those that are theoretical it touches man in every department of his being—physical, intellectual, and spiritual alike In Sir Francis Galton's diction, Is Nature stronger than Nurture, or Nurture than Nature?

It is characteristic of the modern attitude that no investigator thinks that the general and particular problems of heredity are ultimately insoluble Day by day the influence of ancestry is becoming more exactly known, as also the part played by various factors in determining the nature of offspring The necessity of watching and acquainting ourselves with the developments of modern science in this connection is peculiarly important in face of views upon the question that are racial in their influence if not in their ground-work of experience Even the ancient Hebrews had a definite, and in many respects incontrovertible, theory of heredity¹ They were at one with us in perceiving the difficulty of reconciling the apparently exclusive principles of the transmission of qualities from parent to child, and of personal responsibility, but we are nearer the solution than they Meanwhile, the application in the practical sphere is very obvious, for preacher, physician, and social reformer are each compelled to note that men are not alike, that the same treatment is not suitable for every case, and that to be effective, reformation, moral and physical, must be not wholesale, but individual

In a striking study entitled *The Heredity of Richard Roe*, Dr D S Jordan makes an analysis of the physical contents of the "pack" carried through life by the typical individual of that name The handicap imposed by it varies so greatly with different individuals that when, as in the case of Roe's more famous prototype, the pack has become a great burden consciously or unconsciously borne, a whole school of modern philosophy will explain the one in terms of the other, and be ready to acquit the individual of all moral responsibility This, however, is one of the final

¹ Ex xx 5, Ezek xviii 2-4

problems of heredity let us first be present with Jordan at the inventorying of the pack

As the son of his parents, Richard Roe has amongst its contents the burden of his humanity No apology need be offered for this initial seeming confusion between the burden and the man, for it is an instructive biological fact that the man is the burden his humanity itself is the main part of the contents of the pack In common speech, we make a broad distinction between inheritance and inheritor, between property and heir, but in biology the fertilised egg-cell is at once the potential heir and the inheritance This obviously means a complexity of organisation and potentiality in the fertilised egg-cell that almost seems incomprehensible, and yet it is difficult to escape the conclusion The environment certainly plays its part in the supply of the necessary stimuli under whose gentle or rude influence development proceeds, still it is clear that in some measure involution must have preceded evolution Again, his pack will have the distinctive inward and outward features connected with the racial group of travellers to which he belongs That is to say, if he be of Celtic parentage, he will be in nature a Celt there will be no Indian or Mongolian characteristic associated with him He will be fiery, but not with the passion of the south Italian he will be imaginative, but not in the mental symbolism of the Oriental Be he an Anglo-Saxon, he will, at least originally, have combined in him the balance of qualities that has given that people racial predominance

But in addition to his common humanity and his racial qualities, there are in his pack characteristics that will be found in his and in his alone—viz the individual qualities, the distinctive features, the peculiarities by which he is recognised as different from his fellow-packman It is these distinctive physical differences that constitute the variation of the organic world But there are mental differences and varieties of character and temperament that are no less important than these more material differences that we can weigh and measure It is as if after every fresh creation

Nature broke the die. She has no duplicates. One man is not as good or as bad as another. He is himself, and differs in a certain spacious way from every other being. The reason of this has appeared in the course of previous cell studies as they bore on heredity¹. By the law of sex reproduction, Richard Roe has twice as many ancestors as either of his parents had. They may hand on to him any of the hereditary gifts that they received from their predecessors, and in any proportion. We might assume that half of his inheritance came from his father and half from his mother, but we are thrown out in that simple calculation when we find in him qualities that are not apparent in either his father or his mother. It is possible that the new features may be perfect blends of qualities that characterised his parents, but it is just as possible—and in many cases it can be shown—that they represent the characteristics of a yet older generation, so that there is a sense in which Richard Roe is a mosaic of his ancestry rather than an ego. That is to say, in his pack you will find parental qualities, but also those of his grandparents and of his great-grandparents, even of generations farther back. The contents of his pack are historic, samples of the distinguishing, as also of the very ordinary, features of his line.

Richard Roe, then, in his initial stage of a single fertilised egg-cell seems simple enough, but the simplicity is seeming only. How in the mixed chromatin that constitutes the essential feature of the cell lie his potentialities of good and evil, together with the colour of his eyes, the tone of his voice, his peculiar gait—all, in short, that goes to make him what he is and what we know him by—transcends our powers of imagination. It is the wonder of the Infinite—the infinitely little, the infinitely great. In these chromatin granules of his two parents lie his capacities, but amongst them—perhaps latent, perhaps to be expressed—are qualities of past generations that were handed on to them. Not easily does the dead hand let go its grip either in law or in life, but the grasp becomes feebler as the ages roll on.

Of the dual nature of inheritance no one has any doubt, but the conception of this larger multiple ancestral character of heredity—which is simply what we mean when we speak of the solidarity of the human race—is not so frequently before our minds. Yet obviously Richard Roe could not inherit all the peculiarities of his father or of his mother—he could not be composed of peculiarities alone. There is in him a great measure of the old common heritage which was his parents' before him.

Perhaps the most careful attempted statistical conclusion bearing on this subject is that known as Galton's *Law of Ancestral Inheritance*. It was elaborated as the result of that worker's biometrical investigations in the inheritance of such characters as vary continuously and are therefore measurable, *e.g.* human stature, and more particularly in connection with a series of observations on the coat-colour in Basset-hounds. What Sir Francis Galton maintained is, that in the case of every inherited faculty, the two parents contribute on an average one-half, *i.e.* each of them contributes a quarter of the individual peculiarity. The four grandparents between them contribute a quarter, or each of them one-sixteenth, and so on in the series $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16}$, obviously leaving one-quarter of the whole inheritance as coming down from the generations previous to that of the grandparents. There is a point of further interest. We note as a result of fertilisation a persistent tendency to return to the type, and so keep up a specific average from generation to generation, in the absence of stringent selection. Karl Pearson offers a good statistical example. In the case of fathers 72 inches in height, the mean height of their sons was found to be 70.8 inches—a regression towards the mean of the general population, on the other hand, fathers with a mean height of 66 inches gave a group of sons whose mean height was 68.3 inches—*i.e.* they had progressed towards the mean of the general population of sons. "The father with a great excess of the character contributes sons with an excess, but a less excess of it—the father with a great defect of the character contributes sons with a defect, but less

defect of it. The general result is a sensible stability of type and variation from generation to generation”¹ This evident regression towards mediocrity, this tendency to approximate to the mean or average of the stock, is known as the *Law of Filial Regression*. The degree of regression becomes a measure of the intensity of inheritance. As enunciated by Galton in his *Natural Inheritance*, the bearing of the law is sometimes a little difficult to follow. “It must be clearly understood, however,” he concludes, “that there is nothing in these statements to invalidate the general doctrine that the children of a gifted pair are much more likely to be gifted than the children of a mediocre pair. They merely express the fact that the ablest of all the children of a few gifted pairs is not likely to be as gifted as the ablest of all the children of a very great many mediocre pairs”² If you ask the statistician, How do you explain these phenomena of regression and progression? his answer is not far to seek. As Galton has it, society moves as a vast fraternity. A man is not merely the product of his parents but of his ancestry, which in the tenth generation will amount to some 1024 tenth grandparents—an ancestral population whose mean cannot differ greatly from that of the general population, unless there has been extraordinarily careful selection. “It is the heavy weight of this mediocre ancestry,” says Pearson,³ “which causes the son of an exceptional father to regress towards the general population mean. It is the balance of this sturdy commonplace which enables the son of a degenerate father to escape the whole burden of the parental ill.” In other words, children tend to differ from mediocrity less than their parents—that is to say, “the mean deviation of the sons from the mean of the population is less than the deviation of the fathers”⁴ It must be observed, however, that while the Pearsonian induction of a tendency on the part of exceptional groups to return towards mediocrity in the absence of direct interference by Natural Selection is sound, the accompanying deduc-

¹ *The Grammar of Science*, p. 456² *Op cit* p. 106³ *Op cit* p. 456⁴ L. Doncaster, *Heredity*, p. 37

tion, that on cessation of selection the race or species tends to remain stable, is not absolutely valid. Apart from the case of small mutations which will be considered later, the actual appeal to reality shows that with fluctuating universal variations any cessation of selection results eventually in retrogression. The reason of this lies partly in the implications of Recapitulation, partly in those of biparental inheritance. We have seen that inasmuch as the individual recapitulates the parental development, it likewise recapitulates, though much more cursorily, the history of the race. Any retrogressive character therefore that appears must be of the nature of a reversion to some ancestral type—a sort of arrested development so far as failure to advance beyond that particular character is concerned. The ancestral influence might even be regarded as not represented or exerted *en masse*, so to speak, but in an orderly succession. In the absence of Natural Selection these retrogressive variations tend to assert themselves—they have been so long established. Natural Selection has directly to do with progression; retrogression would thus appear to “plane away” redundant, useless variations. Further, this process is aided by biparental reproduction. Blended inheritance, such as is usual in all except certain definite characters,¹ tends to result in retrogression, in a return to the mean type, inasmuch as it substitutes the experience of the race in place of that of the individual. The blending produced as the result of sex reproduction tends to bring about the more or less rapid retrogression of useless characters—a retrogression that is only checked or reversed by Natural Selection. In the light, however, of the more exact modern study of the mechanism of heredity, it must be admitted that Galton's Laws give us little more than the logical inductions that, on the average, offspring tend to resemble ancestors in certain definite degrees, and that the offspring of gifted or deficient parents regress towards mediocrity, judged by the average of a mixed population. His physiological deduction, that ancestors contribute to the heritage of the descendants in

¹ The now well-recognised Mendelian characters. Cf p 174

the definite proportions indicated, is strictly unproved, and it is quite certain that many ancestors do not contribute at all. Further, his inductions, like all such generalisations, can only be used in practice in dealing with the mass of cases. The Laws express the results of statistical studies, and are useless as practical aids to any prediction in the individual instance. They deal with fluctuating variations mainly, and are incapable of emphasising the import of the true variation or mutation, because sometimes failing to distinguish clearly between the two types of variation.

On examination, then, the contents of Richard Roe's pack prove to be a composite of potentialities, the actualising or bringing to light of which depends, so to speak, on the weather in which the pack is subjected to scrutiny, and on the individuals around who have the interest and wisdom to pull out or push back these potentialities, as also on the packman himself. His personality, so largely built up out of elements that have, in a sense, been actually used before him by many others, is the resultant, the *ensemble* of this interplay with the environment. If we fasten our eyes upon his immediate parentage only, we may be perplexed as to the possibility of progress in his individual life, but to do so is to forget that in him lie latent the potentialities of his remoter ancestry, and that if he be brought into the suitable environment they may be actualised. Often it is clearly demonstrated that special circumstances are required to bring a definite group of qualities into public action. Who would ever have heard of John Knox had it not been for the call of that St Andrews congregation addressed to him at an age¹ previous to which most men have shown the promise of their future? Instances can easily be multiplied of men who were made by circumstances, as opposed to those others who have made circumstances, and under Richard Roe's humble name there may lie concealed a noble heritage, which if latent in him, because up to a certain point he has not come under the influence of the appropriate stimuli, may yet be revealed in him or in another generation.

¹ Forty-two

Richard Roe, we stated, had twice as many ancestors as either of his parents. Theoretically this is true practically it certainly is not the case, owing to the intercrossing of families. In most lines of ancestry this must have occurred many times, and as a result a man's whole ancestry will generally be found re-entering at different points in his individual pedigree. So Kaiser Wilhelm II might have had 16, 32, 64, 128 ancestors in the generations IV to VIII, as a matter of fact, he only had 14, 24, 44, 74, and the disproportion is even more marked in the previous generations. A common English family boast is that of descent from some one who came over to England with William the Conqueror. In theory, however, any individual descended from two parents, four grandparents, eight great-grandparents, and so on, would be entitled at the end of the thirty generations between him and the Norman to an ancestry of some 8,598,094,592 souls, and it is only charitable to suppose that amongst that number there was at least one of whom he might be reasonably proud. But, of course, the number of Englishmen in William's or in any time is but a very small percentage of that total, most of the man's ancestors have been included in the tally several times. Descent is not so truthfully represented by a long chain, each link of which will stand for an individual who has left offspring, as by a network, very involved and extended, in which the individual is represented by a strand that is related before and behind and on either side with other strands, in this most complex web of life. Accordingly it is pretty certain that, as Dr Jordan remarks, "the blood of each person in Alfred's time who left capable descendants is represented in every family of England of strict English descent. In other words, every Englishman is descended from Alfred the Great as very likely also from the peasant woman whose cakes Alfred is reputed to have allowed to burn. Moreover, there are few if any who do not share the blood of William the Conqueror, and most ancestral lines, if they could be traced, would go back to him by a hundred different strains. In fact, there are few families in the south and east of England who have not more Norman

blood than the present royal family. The house of Suelph holds the throne not through nearness to William, but through primogeniture, a thing very different from heredity."¹ "There are hardly two persons of European origin," says C. B. Davenport, "who are more distantly related than thirtieth cousin."² The appeal to records, supposing them to exist, in the case of any individual of British extraction, will produce results in this linkage of heredity not merely apparently paradoxical, but which will establish the unity of blood not merely of nations but of all the individuals in any one nation, however removed they may be by artificial social distinctions.³

Theories of Heredity

Of theories of heredity the number has been legion, and a situation has arisen almost comparable to that which enabled Drelincourt, in the eighteenth century, to collect and consider two hundred and sixty-two "groundless hypotheses" upon the subject of the nature of sex, previous to introducing his own speculation, about which "Blumenbach quaintly remarked that nothing was more certain than that Drelincourt's own theory formed the two hundred and sixty-third."⁴ Nevertheless, with Weismann's name is associated a conception of heredity that has at least proved of great service in helping us to think clearly, so far as we may, upon this intricate question.⁵ The conception depends ultimately on the division of the cells of living organisms into the two groups, somatic cells and germ cells. In the nuclei of the latter there is hidden away a mysterious living

¹ *Footnotes to Evolution*, p. 142

² *Heredity in Relation to Eugenics*, p. 188

³ In the case of one family known to the writer descent goes straight back through nineteen generations to Alexander Cleland of Cleland and Margaret Wallace, an aunt of Sir William Wallace, on the one side, and as directly through the Stewarts to Robert Bruce on the other side. In both instances the line is traced through the great-grandmother, and the maternal great-grandmother traced her descent from Bruce through the genealogy of both father and mother.

⁴ Geddes and Thomson, *The Evolution of Sex*, p. 117

⁵ *The Germ Plasm: a Theory of Heredity* (1893), *The Evolution Theory* (1904)

substance, vastly more complicated in molecular structure than protoplasm—the germ plasm—which is handed on from generation to generation, and which, provided the appropriate nourishment is supplied, grows in quantity though remaining unchanged in character. Uninfluenced by anything in its environment, it remains inviolable in the body, much as the gold concealed in the vaults of a bank. More particularly the theory involves these two assumptions (1) the composition of germ plasm out of ultimate units called biophors, which, though composed of several or many molecules, represent single characteristics, and are aggregated into determinants which determine all the physical characteristics of the individuals resulting from the development of the germ plasm, for each determinant is the *anlage* (foundation) of a particular cell or group of cells. Further, these determinants occupy definite positions in the architecture of vital units of a third order called ids (=chromatin granules), and these in turn are aggregated into idants, which are held to correspond to the chromosomes. (2) The second basal assumption is that of germinal continuity from one generation to another. The germ plasm lies secluded from somatic influence. The germ cell of one generation develops partly into the germ cells, and partly into the somatic cells, of the next generation. Germ plasm is convertible into somatic plasm, but not *vice versa*.

Development on this theory, so far as it relates to the body proper, is simply due to the increase and sifting apart through successive qualitative differentiating divisions of the ids of germ plasm, until the particular determinants that control a cell or group of cells have been distributed in a definite and predetermined manner to their respective localities¹. With such a qualitative distribution the longitudinal splitting of the chromosomes comes into remarkable association, as being the only method by which such an end could be attained. In the germ cells, on the contrary, growth and division are accompanied by quantitative distribution of the germ plasm, so that each germ cell contains

¹ The biophors differ qualitatively, and so do their aggregates

identical hereditary matter—will, in fact, contain the same characters as the original fertilised germ cell or egg here also the phenomena of reduction and of fertilisation fall into line with essential features in the Weismannian account. The germ cells in no way contribute to the upbuilding of the body inside which they are maintained. Each of them is practically identical in power and character with the original egg, because of the method of ordinary division. They have been derived by direct descent from that egg, and there is therefore a sense in which the child is as old as the father. The second generation has, strictly, in-

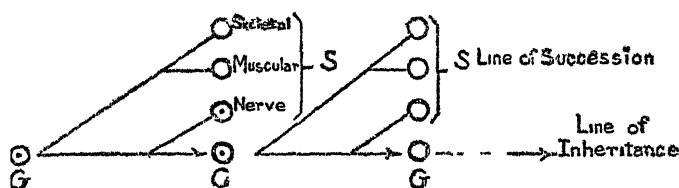


DIAGRAM ILLUSTRATING WEISMANN'S THEORY OF INHERITANCE
G. The germ cell, which by division gives rise to the body or soma (S) and to new germ-cells (G) which separate from the soma and repeat the process in each successive generation

[Adapted from Huxley]

FIG 9

herited nothing from the first. It is like it because it has developed from part of the same germ plasma. Accordingly, it is obvious why children tend to be like their parents. The differences between the generations are due to the fact that at every creation there is a mixing of two germ plasmas of different ancestral origin. The genetic variations arising in this way, being inborn, tend to reappear in succeeding generations. On the other hand, no modifications (acquired characters) can be transmitted. External influences only affect the somatic cells: such changes as take place there cannot be registered in the germ cells, although the latter may be directly modified by influences (*e.g.* poisons). It is only the character of the germ plasma that determines the inheritance of the subsequent generations.

The individual is simply a trustee of the germ substance for future generations no disasters which affect him, and no favourable circumstances either, can alter the character of the hereditary substance which he transmits to the next generation

Such conclusions, which largely dominated biological thought during the last quarter of the nineteenth century, cut, of course, at the root of the whole Lamarckian interpretation of evolution, which was based upon the inheritance of modifications, the transmitted influence of use and disuse being the fundamental law of that doctrine Even Darwin admitted the part played by the Lamarckian factors in descent, turning to them whenever Natural Selection was faced by difficulties it could not solve But if the Weismannian view is right, the Lamarckian factors count for nothing The environment does not affect the germ plasm, and cannot therefore affect posterity Evolution is simply an evolution of germ plasm, and only incidentally of the individual This necessarily involved Weismann in regarding all specific characters either as useful, or correlated with useful characters He was further compelled to explain the seeming effects of use and disuse either by Natural Selection, or by the withdrawal of Selection in the case of non-useful characters

It must be admitted that till quite recently no very satisfactory evidence has been adduced of the transmissibility of modifications, possibly in part because no observation or experimentation has been carried out on a sufficiently broad scale Ever since Weismann repeated the classical experiment of the farmer's wife, and found out that the progeny of the mutilated mice were born with tails, a tendency has grown up to relegate the evidence for the transmission of modifications to the realms of mythology Many circumstances which suggest such transmissibility are found upon examination to break down Thus the change in the offspring must be strictly and definitely in the same direction as the original modification, before we can speak of its inheritance Many cases of what appear to be inheritance of an acquired character are probably not so correctly

interpreted along those lines as in terms of the inheritance of a certain degeneracy of nature, which may show itself in the same particular way in a child as in its parent, but on the other hand may express itself in a totally different manner in the second generation. The degeneracy of nature thus handed on would be of course of the nature of a genetic character, and therefore, *ex hypothesi*, heritable. It is not the acquired character that is inherited, but the innate power of acquiring it is transmitted. Then, again, there is no doubt that we must recognise the possibility of concomitant change of the germ cells along with the somatic cells. There is here no question of transmission, for the same cause may produce very different effects in the two generations. Further, all the germ cells might conceivably not be affected alike, and a difference of effect would be seen in the various members of the second generation. This seems to be the interpretation of results got by Standfuss from the experimental treatment of butterflies and other insects, *eg* submitting them to change of temperature. Finally, in the case of the higher forms we realise that all characters are developed at some stage under the action of different kinds of stimuli. The difficulty with the Lamarckian view was to show how an acquired modification could be transmuted into an innate character, how, that is to say, a character developed in one generation under the stimulus of use could be developed in the second generation under a different category of stimuli, being now educed by nutriment, and how, being so transmuted, it could still preserve its original utility.

On the other hand, it has become increasingly clear that Weismann's conception, marvellously as it fitted the facts up to a certain point, must be considerably modified. For there are facts which go to show that this germ plasm is not the absolutely stable substance that he, at least originally, maintained it to be. Even if it were, how could it have ever acquired any differences? Other facts, such as those of regeneration of lost parts amongst lower animals, and budding in plants—even the ability of each of the cells of the 16-cell *Echinus* to

reproduce a dwarf whole—prove that the germ plasm, if early segregated in the case of higher animals, is not necessarily restricted to the germ cells in the case of these humbler forms. This concentration and growing specialisation of cells seems to indicate the localisation and concentration that are the insignia of a higher life. But, more positively, there is no question to-day that environmental influences can affect the germ, and while the Neo-Lamarckian does not contend that modifications acquired or developed in one generation are reproduced in detail in the succeeding generation, he finds no warrant for dogmatic statements to the effect that such modifications are always without influence on progeny. It seems to him reasonable to suppose that every obvious effect produced in an organism may be accompanied by a more or less corresponding, though much slighter, effect upon the elements in the germ plasm, and express itself in the next generation as an apparently cumulative effect of the changed environment, or the effects may be totally invisible until, after generations of exposure to the influences, the inherent stability of the organism is overcome. Further, the study of the part played by hormones in the economy of the body supplies the data, hitherto lacking, for representing to ourselves how changes in tissue, due to environmental stimuli, might affect germ cells, and so the succeeding generations ¹ to what degree hormones, enzymes, and anti-bodies may affect the germ plasm specifically and so modify inheritance, has still to be ascertained. This does not mean, however, that such transmutation of modification into genetic character necessarily takes place in every case. When it does occur, it may often be the work of generations. But roundly to deny this possibility, on the strength of any present-day facts or theory, seems not merely illogical in view of the certainty that all inherited characters must have been originally acquired under environmental influence at some definite period, and that transmission of modifications takes place in the Protozoa, which are ancestral to the Metazoa, it also disregards one of the

¹ Cf J T Cunningham *Hormones and Heredity*

best grounded generalisations of biology—the unity of the organism—and leaves evolution without a sound rationale of progress

With regard to the crucial matter of evidence, the Neo-Lamarckian case seems now to be in a stronger position than at any previous period. Richard Semon, in his important work,¹ has referred to some of the more recent evidence, in support of his mnemonic theory of inheritance, *e.g.* Bordage's peach trees,² and P. Kammerer's experiments on the toad *Alytes obstetricans*.³ His own ideas, which are akin to those of Samuel Butler,⁴ and Ewald Hering, explain the phenomena of inheritance as due to a kind of unconscious memory of the experiences of past generations on the part of the developing organism. Such a position, of course, involves belief in the inheritance of acquired characters. He assumes that the germ cells, like other cells, can respond to stimuli by some definite alteration in their condition. The stimuli to which they respond are changes in what he calls the "energetic situation" of the whole organism. The stimuli are supposed to leave a sort of lasting record of themselves—a "residual effect"—upon the germ cells. To this unified stimulation-complex, the name of "engram" is given. These modifications of the germ cells affect their development,

¹ *Die Mneme als erhaltendes Prinzip im Wechsel des Organischen Geschehens* (3rd edit. 1911)

² *Op cit* p. 79. Bordage found that European peach trees grown in the coastal region of the tropical island of Réunion lost their deciduous character and became almost completely evergreen after twenty years. He further found that the seeds of these modified peach trees produced young evergreen peach trees when sown in another district at an elevation of over 3000 feet, where seeds of the ordinary peach tree produced the normal deciduous type in its temperate climate. Here evidently is a clear case of the transmission of a character acquired under the influence of change of climate.

³ *Nature*, vol. cx1 pp. 637-640. For later examples, cf M. F. Guyer and E. A. Smith "Studies on Cytolysins. II. Transmissions of Induced Eye Defects," *Journal of Experimental Zoology*, vol. xxxi, Aug. 1920, C. R. Griffith, "Are Permanent Disturbances of Equilibration Inherited?"—*Science*, vol. lvi pp. 676-678.

⁴ Cf. especially his *Life and Habit* (1877) and *Unconscious Memory* (1880), in the latter work he includes a translation of Hering's address, "On Memory as a Universal Function of Organised Matter" (1870). Cf. also James Ward, *Hereditry and Memory*.

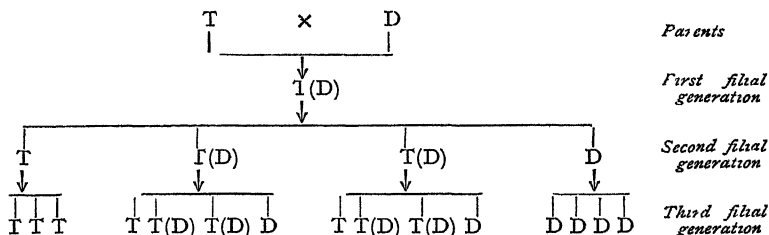
"because the engrams are called forth in due sequence by appropriate stimuli and express themselves in corresponding modifications of the body of the offspring. The germ cells are thus stored with the latent 'memories' of past generations, and they may contain many engrams that may never get the chance to express themselves in any particular individual ontogeny. Thus a number of alternative routes are open to each individual at the commencement of its life-history, and the particular route followed will depend upon the nature of the stimuli which the developing organism happens to encounter"¹ On such a view ontogeny is a mnemonic phenomenon, it is of the nature of a habit. "Germ cells must, like nerve cells, contain engrams, and these engrams must be (like nerve-engrams) bonded together by association, so that they come into action one after another in a certain order automatically, *i.e.* in the absence of the original stimuli"² Semon avoids all molecular interpretation of the engrams, although he localises them chiefly, if not exclusively, in the nuclei of the germ cells. Nor does he attempt to explain how the necessary stimuli reach the germ cells, although the fact is held to be demonstrated in the experimental data cited.

It is peculiarly important to bear some of these considerations in mind, in view of the brilliant intensive work that has followed the rediscovery of the remarkable facts first ascertained by Gregor Mendel, Priest of the Konigskloster in Brunn, about 1865. These bear on the heredity of hybrids, and establish the purity of certain germ characters. Mendel's procedure was to fix on definite unit characters (always found in alternative pairs) and study the manner of their inheritance. This was found to take place in perfectly distinctive and calculable ways. To take but one example, he crossed different varieties of the edible pea, *e.g.* the tall, and the dwarf. In the first filial generation of this cross, all were without exception tall. But in many of these

¹ A. Dendy in *Nature*, vol. lxxxviii, p. 371, cf. also his *Outlines of Evolutionary Biology*, chap. xiii.

² F. Darwin, Presidential Address, *Brit. Assoc. Report*, 1908, p. 17.

the dwarfness proved to be latent, for in the second filial generation, each flower being self-fertilised, only 75 per cent were tall, and the remainder were pure dwarf. The next generation produced as remarkable results. The dwarfs bred true, but of the 75 per cent of tall, only one-third, *i.e.* 25 per cent, bred true, the remaining two-thirds produced 75 per cent of tall and 25 per cent of dwarf. Or in diagrammatic form



Now, the implications of these and many other data are as follows: that in all forms of life as part of the inheritance there are regular, well-defined, unit characters, structural and physiological, existing in pairs, which, when the possessors are crossed, do not blend, but appear, the one or the other, in the next generations in definite proportions, that each such character is represented in the chromosomes of the germ cells by a definite factor, determiner or "gene", that one of these characters is dominant over the other, which is there in the individual resulting from the zygote, though invisible, and that either can be bred pure. Mendel explained his results by segregation, which accords with what is known to take place at the reduction division in the maturation of the germ cells¹. He supposed that the germ cells of the hybrid contained one or the other of a pair of alternative characters (allelomorphs), but not both, as in the case of the hybrid zygote of the first generation, and that these germ cells are produced in equal numbers, each gamete, that is to say, is "pure" in respect to any given unit character. Offspring in which similar individuals of a pair are united will breed

¹ Cf p 87

true to the character in question, irrespective of their ancestry. In the case of the edible pea, Mendel found several pairs of alternative characters. Purple and white flowers, rounded and wrinkled seeds, and so on, were proved to be dominant and recessive respectively. Now various new pure combinations of these allelomorphs can be obtained. For by crossing the tall purple with the short white, we get not merely these forms in the second generation, but also short purple and tall white, and by selecting the pure individuals, pure races of the new types can be established. It is as if, without altering the fundamental character of a building, different individual stones could be substituted in the place of others. In some more complex cases, allelomorphs of distinct pairs react on one another so as to produce a linked or grouped effect in the individuals possessing them. The practical value of the discovery lies in the fact that, to take another example, it is found that in wheat, resistance and non-resistance to the attacks of disease, earliness and lateness of ripening, good and bad milling quality, strength and weakness of stem, are all pairs of Mendelian alternatives, and it has been found possible to take a different example of these qualities from each of these different strains and combine them together in a single new variety with perfect certainty in four generations. It has been found possible by crossing immune and non-immune strains to obtain a pure, rust-free wheat in three generations, thus answering the old question, "Who can bring a clean thing out of an unclean?" and answering it differently from Job¹. The Mendelian formula may thus be applied to the individual with definite prediction. The statistical study of heredity bears only on the group. The former is practical, the latter is theoretic.

Again, Darwin's idea of evolution supposed that it was achieved by the continuous and gradual alteration of the specific mean through the selection of fluctuating variations. This is the view of the biometrician, in part conditioned by his method. He deals with great

¹ Job xiv 4

numbers of individuals, he notes the continued tendency of offspring to regress towards the mean. His biggest variations are not isolated, being linked with others by intermediate degrees. The Mendelian does not deny the existence of those normal fluctuating variations, but he insists that they are useless to evolution. They tend to return to the mean so strongly in succeeding generations, that they cannot, under any degree of stringency, serve as elements of permanent racial divergence. And he thinks that evolution proceeds by the selection of the non-blending discontinuous stable variation. These are the characters he is likely to notice, for he works with individuals rather than with aggregates. Some of the offspring will show this discontinuous variation, others will not. If it is favourable, it will be preserved; if it is not, it will be lost.

How far the Mendelian law applies to man is a question to which as yet a complete answer is not forthcoming. It is obvious that the practical study of human heredity must offer difficulties that are peculiar to the case. Human families are not large as a rule, and cannot be the subject of experiment, four generations require a century, and records are rarely preserved with care. Further, it is extremely probable that, owing to the long line of ancestry that leads up to man, human characters are very subtle complexes which will require much disarticulation before we get down to the unit characters out of which they are built, and it is these unit characters whose behaviour is expressible in terms of the Mendelian law. The Mendelian formula is as yet inapplicable to the inheritance of mental traits with any exactness, precisely because the psychologist has not yet enabled us to analyse even the simplest psychical characters into their fundamental units. On the other hand, in a rough general way we have the data of generations as we have them in the case of no other creature, and it is already clear that many characters do conform to a Mendelian interpretation of their transmissibility.¹ If blending seems to be the rule in human inheritance,

¹ More than sixty human traits are already in the Mendelian catalogue

and thus excludes man on the whole from Mendelian interpretation of his heritage, it may still prove to be the case that "blending inheritance" is after all "due not to the real fusion or blending of inheritance factors but to varying combinations of numerous or multiple factors, according to the Mendelian rules"¹ If the features that have been shown most markedly to follow Mendel's law are abnormalities rather than normalities, this may be merely owing to the greater ease with which they are observed and recorded Of normal characters, eye-colour has so far provided the best demonstration It is probable that "the complexity of the transmission of the various colour-characters,"² *e.g.* eye and hair, is greater in the case of our mixed Western European populations than it is amongst plants and lower animals The presence of pigment on the front of the iris gives us brown or black eyes, its absence produces blue or grey eyes The results of Hurst's investigations on the parents and children of a Leicestershire village go to show that brown eyes are dominant to blue eyes Again, "the segregation of red hair from black hair may be seen in many families, and this red is presumably a recessive"³ In the case of disease and malformations, a close study of their transmission has been undertaken along these lines, and the indications so far are that in the majority of instances the abnormal feature is dominant to the normal Brachydactyly and cataract, to take but two examples, prove themselves transmissible in the proportions expected Albinism, and one or two rarer pathological conditions, prove themselves recessive The recessive character is distinguishable by the fact that it may be recognised in the children of parents who are without it, and particularly in the offspring of consanguineous marriages Further, it becomes increasingly probable that the dominant condition is due to the presence of some element added to the normal composition of the body, while the recessive type of disease is due to the absence of some element that we may expect

¹ E. G. Conklin, *op cit* p. 113

² W. Bateson's *Mendel's Principles of Heredity*, p. 205.

³ *Op cit* p. 206

in the normal body. Finally, this discussion of the dominant and recessive characters of specific diseases will banish any preconceived association of dominant characters with qualities that from another point of view we may consider "good." As a matter of fact, we know that in wheat, resistance to rust disease is a recessive—that is to say, the good has to be won from the evil, and the condition of its existence probably consists in the absence of some element, found in ordinary wheats, whose presence renders them an easy prey to the rust-fungus.

At the same time, in the experimental application of Mendel's *Law of Alternative Inheritance* to the solution of the complex facts of plant and animal life, it has been found that the earlier statements of the relations subsumed under it were too rigid and absolute. Thus dominance is sometimes incomplete. The influence of the recessive may show itself in greater or less degree, the distinction is, in point of fact, one of degree rather than of kind. Further, it is now apparent that while some characters are determined by single genes, others are the product of multiple genes, and dominance then comes to be "a relation between a pair of genes rather than between their expressions"¹ or characters. Experimental evidence also shows that dominance may depend on environmental conditions just as much as upon any particular combination of hereditary units. "The appearance of any developed character in an organism depends upon many complicated reactions of germinal units to one another and to the environment."² It is also probable that sex inheritance, so far as that is associated with the transmission of the accessory chromosome,³ follows the Mendelian formula, and the fact that certain abnormalities, *e.g.* colour-blindness, are sex-linked—*i.e.* transmitted, it may be, from father to daughter or mother to son—becomes intelligible when seen under the Mendelian searchlight. At whatever point the investigation is pursued, evidence is disclosed

¹ L. L. Woodruff, *Foundations of Biology*, p. 286

² E. G. Conklin, *op cit* p. 107

³ Cf. p. 87

of a realm of order even in these deepest aspects of the continuity of life. At the same time, it must be evident that Mendelism throws no direct light upon the ultimate question of the origin of characters and so of species, it is concerned merely with the transmission of characters. There is almost a note of despair in a recent pronouncement by the English high priest of Mendelism: "In dim outline evolution is evident enough. From the facts it is a conclusion which inevitably follows. But that particular and essential bit of the theory of evolution which is concerned with the origin and nature of *species* remains utterly mysterious."¹ But it is only a Mendelian who would have expected that along that particular line a complete account would have been forthcoming. The problem is a larger one than Mendelism alone can solve, but that does not necessarily mean that it is insoluble.

Inheritance of Mental Characters

To leave physical characters and pass to the general consideration of the inheritance of mental and moral features is to enter a field where qualitative rather than quantitative tests must ultimately prevail. Nevertheless, as far back as 1869, Galton, in his work *Hereditary Genius*, showed that within a certain range the quantitative test produced results. Later, Karl Pearson, applying the statistical methods used in calculating the inheritance of physical characters to data furnished by school teachers' reports on such characters as popularity, vivacity, ability, and handwriting in their scholars,² maintained that "the degree of resemblance of the physical and mental characters of children is one and the same," or more concretely, "we inherit our parents' temper, our parents' conscientiousness, shyness, and ability as we inherit their stature, forearm, and span." With regard to Pearson's particular method of argumen-

¹ W. Bateson, "Evolutionary Faith and Modern Doubt," *Nature*, vol. cix, p. 553.

² "On the Inheritance of the Mental and Moral Characters in Man, and its Comparison with the Inheritance of the Physical Characters" (Huxley Lecture for 1903, *Journal Anthropological Institute*, vol. xxxii, pp. 179-237).

tation, it should, however, be noticed, that because certain characters appear in certain similar proportions, it does not necessarily follow that they are both "innate." There are other characters in which presumably similar degrees of likeness could be shown, *e.g.* ability to speak or write the English language, which are obviously acquirements, and not innate. Pearson can show the degrees in which certain definite characters are reproduced under certain definite conditions, but he offers us no criterion by which to decide whether characters are innate or acquired.

The fundamental similarities in racial, national, and even occupational mental character, the universal re-emergence of primitive instincts, feelings, and specific responses to stimuli, seem to point in the direction of some considerable degree of inheritance even of mentality. Possibly the initiatives of moral character are transmissible just as physical tendencies are: temperament, emotional nature, strength of will, judgment, are all in great measure hereditarily determined. Indeed Davenport, on the basis of broad investigations covering several generations, feels justified in claiming hereditary transmission, with almost Mendelian exactness, of such emotional traits as the tendency to violent outbursts of temper, marked eroticism, suicidal impulse, dipsomania, and nomadism he finds to be sex-linked characters.¹ What we must recognise is that physical characters are almost entirely fixed by heredity in modification of them man cannot do very much. They are genetic and transmissible, and improvement is appallingly slow. In the case of certain grades of mental characteristic the same holds true, but as we rise in the scale of those mental, moral, and spiritual features that are most distinctive of man, we realise that increasingly they are of the nature of acquirements. The distinction between the genetic character and the acquired character or modification thus comes to be peculiarly important in the case of man. Consciousness, and the power of memory which stores the impressions of consciousness, are genetic

¹ C. B. Davenport, "Heredity of some Emotional Traits," *Brit Assoc Report*, 1914, p. 419

characters, as also the power of thought, which is so intimately associated with the other two their stores are all acquirements. Several human instincts are limited to the earlier phases of man's life, during the long helpless period of infancy, the power of acquiring is slowly maturing and developing behind a few protective instincts. His mental and spiritual life consists largely in the controlling and transmuting of instinctive impulses, and in acquirement, in fact, the ability to make acquirements is a distinguishing feature of man. He is, as Shaler long ago remarked, essentially the "educable" animal. On the other hand, the whole life of many animals is instinctive in activity all their characters are inborn. There are none of those modifications that arise as the result of consciousness. As we ascend in the mammalian scale, the growing feature is the increasing power of devising and making acquirements. The more instinctive the life, the more is it a uniformity from beginning to end the insect is practically as clever on its birthday as on the day of its death. The less instinctive the life, the more guided by intelligence, the less of a uniformity is it, and the more of a progressive growth. Social customs, morality, and religion are the result of nurture, and in those spheres the environment has the determining and final word.

CHAPTER IX

SOME SOCIOLOGICAL ASPECTS OF HEREDITY

IN the case of man it is obvious that questions of Heredity and of the influence of Natural Selection take on a somewhat different guise from that which they wear in the case of humbler forms of life. Not merely is there little of the struggle for existence in its life-and-death aspect amongst the human races of to-day, but we become at once aware of numerous ways in which man in virtue of his educability and mental plasticity can modify, and in part create, some of the elements in his environment, so that Natural Selection, so far as he is concerned, is gradually being replaced by Rational Selection¹. Every stage in the evolution of forms below man bears a direct and constant relation to the physical environment mainly. In the case of man a distinction has arisen whereby the strictly biological aspects of human evolution, directly related to the physical environment as with the lower forms, have not stood in any close association with that social evolution that has been so marked a feature of mankind. His ability to preserve and make use of the social experience of the past has led to a certain disparity of advance between his social evolution and that biological evolution which means change in innate character. Progress in the former sphere is obvious; in the latter it is hard to demonstrate. Even such an old form of Natural Selection as war, in killing off the biologically fit, and in time of peace giving an advantage economically to the physically defective, operates in a method precisely the reverse of that which underlay its working in the earlier stages of civilisation.

¹ A great though not permanent exception, however, still remains in the case of zymotic disease.

Hitherto, man's interference with the factors that operate in the biological evolution of the race, such as Natural Selection, Sexual Selection, Isolation, and so on, has had no direct relation to the factors operating to bring about social evolution. The time is approaching, however, when these two aspects will be kept in constant conscious association. A variety of circumstances is combining to quicken reflection upon the kind of use that is being made by man of his power of consciously modifying in part his own evolution. The issue is raised in connection with modern methods of procedure in the production of national efficiency, about which it may be fairly questioned whether they are not producing results that may ultimately be nothing less than disastrous. Inquiry arises on many sides as to whether the particular modern trend of social progress is really progressive, and tending towards a biological improvement of the race. In the strictly scientific use of the term, the struggle for existence results in the survival and reproduction of certain fittest forms: whatever content there is in this fitness, it is something physical. In the case of the human species there is, however, little struggle in this sense, as we have seen, indeed, it is the physical unfitness in the form of "national degeneracy" that at once arrests attention in connection with this easing up of the struggle. History has already compelled the question why imperial races, rather than their conquered subjects, have ultimately degenerated—why it is that nothing *fails* like success? The problem to be considered is whether the particular lessening of the stringency of Selection is compensated for by the undoubted greater fitness of social life and institutions, into which channel the force of evolution is being directed by man himself.

It may be considered first from the point of view of the present declining birth-rate, to which Karl Pearson¹ and many others² have drawn attention. The total number of births registered in 1910 in England and

¹ Cf. *National Life from the Standpoint of Science*

² e.g. the Bishop of Ripon at the Anglican Church Congress in 1910

Wales was 896,962, equal to 25 1 per 1000¹. This was no less than 2 5 per 1000 below the average in the preceding decennium and 0 7 below the rate in 1909. In 1876 the births were equal to 36 3 per 1000. The Registrar-General's Report indicated further that the trend of the birth-rate was still downwards, the provisional rate for 1911 being yet lower, viz 24 4 per 1000. Nor was the decline confined to the mother country. In thirty years the birth-rate in Australia has fallen from 35 2 to 26 7 per 1000, and in New Zealand from 36 3 to 26 2. A phenomenon, therefore, which has hitherto been prominent in France, confronts whole English-speaking portions of the Empire. If the diminution of the birth-rate could be shown to prevail among the unfit, the phenomenon might be viewed without apprehension. It might even be welcomed in evidence of the existence of noble and self-denying ideals. Statistics, however, prove conclusively that the decline is most marked in the middle and professional classes, where the intelligence and physical ability of the nation are to the greatest extent segregated. As a result, these are being steadily recruited from the lower and less intelligent strata of society, or to put it in other words, there is a gradual breeding out of intelligence. If present tendencies continue, the proportion of the fit to the unfit will steadily decline. Further careful statistics show that the birth-rates in the various districts of our cities are in inverse ratio to their wealth, that, over all, the upper classes tend to marry later in life with decreasing fertility, and that the population tends to be recruited chiefly from the earlier marrying so-called lower strata of society.

It is also noteworthy that the decline of the birth-rate in the British Empire synchronises with an increase in the birth-rate in the East. The remarkable emigration from China to various localities suggests a pressure due to over-multiplication which can only be roughly estimated in the case of that tremendous population. In the twenty-three years between 1886 and 1909, when

¹ No attempt has been made to introduce later statistics, owing to the general and abnormal upheaval brought about by the Great War.

the birth-rate in the United Kingdom fell from 31.4 to 25.8, the birth-rate in Japan rose from 28.5 to 34.2—her rise being greater than our fall. From the same date to 1910, Ceylon showed an increase from 30.3 to 39. “It is not going too far,” said the Bishop of Ripon, “to say that while the populations which claim Western civilisation show signs of diminished fertility, the East is growing in consciousness of strength, in alertness of perception, in supple power of adaptation, in vigour, self-denial, and numbers. Are we witnessing the decline of the West and the rise of the East? Are the nations that have been entrusted with the guardianship of the Christian faith refusing their inheritance, and by an inexplicable race suicide surrendering the sceptre to the East?”¹

Again, of undesirable variations from the racial mean fraught with serious consequence, none are more deadly than insanity and feeble-mindedness, yet man's interference with his own evolution, however questionably successful in other directions, has not been exercised in any suitable degree in the worthy and practicable aim of checking such tainted streams as have flowed continuously for several generations. Mental disease is undoubtedly increasing at a rate which is out of all proportion to the increase of the population. It is hereditary, indeed, the soundest treatment is prevention. From evidence given before the Royal Commission on the Care and Control of the Feeble-minded (1904), we learn that in England and Wales 271,607 persons may be considered as suffering from mental defect, of whom, apart from the certified lunatic, 150,000 are not sane but are not certifiable, while 66,500 urgently need proper supervision.² Of the inmates of the Poor Law institutions, excluding pauper lunatics, from 12 to 18 per cent are mentally defective, and in the prisons there are to be found every day from 3000 to 4000

¹ *Report of the Church Congress* 1910 p. 166

² According to other returns the number of certified insane persons under care in England and Wales on 1st January 1912 was 135,661, or 2504 more than in the previous year. The ratio of insane individuals to the population has increased during the last fifty-three years by 98.8 per cent, till now the proportion is 1 in 269.

defectives Evidently, then, we have a great mass of mental degeneracy, which, when it is not living at the cost of the taxpayer in workhouse or in prison, or being supported by charity,¹ is wandering about the community, idling and working mischief, or settling down and reproducing its kind at abnormal rates² As a part result, we find in the elementary schools 35,662 mentally defective children, of whom some 50 per cent will never be able to earn their own living Into the causation of this increase in mental degeneracy, apart from genetic strains, several factors enter—alcoholism, general progressive paralysis with all that its etiology implies, and the pressure of economic life

A third feature with disquieting implications is the complacent perpetuation of certain criminal strains that in their persistency almost seem analogous to a Mendelian extracted pure character Some of these are very closely connected with the condition previously examined Probably the best known instance is R A Dugdale's study of "The Jukes"³ This he began in 1874 as a New York State Prison Commissioner "The Jukes" is the name given by him to a large group of degenerates It is not the real name of any family, but a generic term applied to 42 different families, whose inter-relationships were made the subject of investigation The word "juke" means to roost, and is used by Dugdale to designate the members of this tribe of Ishmael, who failed to rear good homes, or provide themselves with the necessities of life by honest, steady work Dugdale, in the course of his prison investigations, was surprised to find six criminals in one prison who, though under four family names, proved to be blood relations in different degrees Accordingly he set to work to unravel

¹ The annual cost of maintenance of mentally defective children, paupers and prisoners amounts to about £635 000 Under the recommendations of the Royal Commission on the Care and Control of the Feeble-minded this figure would be raised to £1,175,000

² The average normal family (parents excluded) is four in the degenerate family the average number of children born is eight

³ For fuller and more recent studies, reference may be made to C B Davenport, *Heredity in Relation to Eugenics*, S J Holmes, *The Trend of the Race*, E G Conklin, *The Direction of Human Evolution*

the history of the tribe. He traced it back, on the one side, to an individual he calls "Max," born between 1720 and 1740 of Dutch stock, who lived a kind of backwoodsman's life in a lake district of New York State, but was essentially an easy-going, dissolute man. The starting-point on the other side is furnished by a group of six women, sisters in some degree, two of whom married two of Max's many sons. Dugdale learned details of 834 descendants of seven of this group through as many generations, and with collateral lines traced the history of 1200 "Jukes." Owing to the accidental discovery of Dugdale's original manuscript with the real names of the individuals, it was possible for Dr Estabrook of the Eugenics Record Office to continue the investigation of the history of the tribe¹. This he did down to the year 1915, and found that while the numbers had increased rapidly, there had been little or no improvement in the general character of the Jukes. He notes in particular the large proportion of feeble-mindedness amongst them. The almost universal traits of the tribe were idleness, ignorance, and poverty, all combined with great vitality. Their refusal to work or to study led to disease and disgrace, to pauperism and crime, to feeble-mindedness and insanity. Nor did their crimes or their pauperism show any redeeming feature. It was all sordid, with nothing heroic, clever, or honourable. So far from contributing to the world's prosperity, they cost the State more than 1000 dollars apiece in seventy-five years, including men, women, and children. Those who worked did the most menial labour, commanding the poorest wages. Of the total number of men, not 20 were skilled workmen, and 10 of those learned their trades in the State Prison. None of them was regularly employed, and the study of this tribal indolence and inability to persist in any task, owing to lack of discipline and education, indicates that it is easier to reform a criminal than a pauper. Of the 1200, some 300 died in infancy from lack of proper care and favourable conditions. Of the remainder, 28 were professional paupers who lived in poorhouses or

¹ A. E. Estabrook, *The Jukes in 1915*

their equivalent for 2300 years More than 50 per cent of the women led lives of notorious debauchery, 440 men and women were physically wrecked in early life by their own wickedness, 60 were habitual thieves, 140 were convicted criminals, and 7 were murderers These summed results arrest attention, but even more impressive is the detailed study of the several family lines, generation after generation, which brings out a tendency to the segregation of licentiousness, criminality, and pauperism in the different strains Of a similar character, and with still more detail, is Jorger's unravelling of the Swiss family "Zero"¹

These may appear extreme cases, but in a paper read at the Church Congress in 1910,² Mrs Pinsent of Birmingham cited several cases of mentally defective families in which mental defect and criminal propensities could be traced through three or four generations The cost of such families to the community, she pointed out, was very large Fourteen individuals out of nineteen, in the third generation of one family with only a single normal representative, had been supported at public expense in industrial schools, prisons, reformatories, asylums, workhouses, and homes Five publicly paid officials were constantly visiting one other family, where a mentally deficient mother had borne ten children, four of whom were mentally defective and two physically defective, while three died in infancy The whole of the time and money spent on improving the environment of this family was wasted, for in spite of the united efforts of these five officials not one of these children could possibly become a useful citizen The training and support of these degenerate families ultimately falls so heavily on the efficient members of a community, that they are sometimes led to limit the number of their children, and also the educational opportunities they could afford them, thereby impairing their usefulness

By way of contrast, the story of Jonathan Edwards'

¹ *Archiv für Rassen und Gesellschafts Biologie*, Berlin, 1905, 11 pp 494-559

² *Report of the Church Congress*, p 151

descendants may be set down¹ The great American divine was born in 1703 He had eleven children, and a study has been made of 1400 of his descendants, which includes those men who have married into the family Of these, amongst the men alone—and the record is not so complete as in the case of the Jukes—285 were college graduates, including 13 presidents of universities and colleges, 65 professors, and many principals of important academies and seminaries Every department of learning and human activity in the United States has been adorned by men of distinction belonging to that family, while there was not a single criminal or pauper amongst them to stain the family name² At every point the contrast with the Jukes is very striking, and again suggests the analogy of an extracted Mendelian pure character Further contrasts in inheritance of ability, musical, religious, scientific, and criminal, may be found in various classical studies

Another criterion whereby the efficiency of man's interference with his evolution may be gauged is found in the growing increase in the rate of suicide The isolated accounts of suicide in the newspapers lead us to think of it as an individual affection This is very far from being the case indeed, in some morbid conditions, *e g* amongst Russian political prisoners, it has sometimes become epidemic Further, the tendency shows a marked increase not merely in Great Britain—where for England and Wales the Registrar-General in his Annual Report for 1910 gives figures that show an increase of from 86 to 100 per million during 1891-1910—but in most countries of Europe In Petrograd, a city whose population, including that of the suburbs, was 1,927,000 people in 1909, there were 1432 cases of suicide, a figure which showed a marked increase on that of any year in the previous decade

When we attempt to elucidate the causation of suicide, the common but often unreasoned association with insanity by coroners' juries may easily lead us

¹ A E Winship, *Jukes-Edwards*, chap 11

² The name of Aaron Burr may occur to some as an exception, if so, he is a remarkable exception wherewith to prove the rule

very far astray, as the following human document from the pen of a Russian student will show "Fancy you see before yourself a man who is ill with an incurable illness—tuberculosis He is at present not more than twenty-one years of age in four years this man will not be on earth any more The thought of the inevitable death causes such experiences for the depiction of which there are no expressions in our language This thought poisons the remnant of life which remains to him I do not now speak of physical sufferings Would it not be better for such a man to deliver himself and others from such an existence on earth? Logic says the following (1) That the earth is too small for humanity if some did not die, others could not have room or means for existence (2) If God exists, then maybe on the other shore a man will get something better than sleepless nights and an endless deadly craving (3) If God does not exist, and if death is only a return to the condition in which a man was before his birth, then it is better at once to be delivered from all this torment HCN (prussic acid) kills instantaneously and without suffering true, the rest is silence, but better eternal silence than four years of inquisition I greatly beg you to answer, because this question is from one of those whom you see before you, a question of the present day, a question of life and death I have courage to do away with myself, but I would wish to act in accordance with higher truth "

If there were a regular direct connection between insanity and suicide, we should expect that the sex and country with the highest insanity records would show the heaviest suicide-rate This, however, is very far from being the case Statistics show that while insanity is on the whole slightly more prevalent amongst women than amongst men (although the difference is as much as 11 per cent in the case of Norway), suicide is markedly more characteristic of the male than of the female sex Norway and Scotland, according to figures that cover periods in the second half of last century, stand first and second in the insanity record of nine European countries, but on the corresponding suicide record, their places are fourth and eighth Denmark

and Saxony, where suicide is most common, are third and eighth in the insanity returns¹

More interesting is the clearly proved fact that suicide is much more common in Protestant than in Roman Catholic communities. A careful examination of returns from Switzerland showed that in the French-speaking Catholic cantons the suicides numbered 119 per million inhabitants, in French-speaking Protestant cantons, 352, in German-speaking Catholic cantons, 137, in German-speaking Protestant cantons, 307. In Protestant Saxony on a ten-year average there were 330 suicides for each million inhabitants, in France, 225, Austria, 163, Italy, 58, Spain, 18. The reason of this is, in part, probably bound up with the greater social integration and cohesion of Roman communities. Not even the proverbially integrated Jews, welded together under the pressure of an unsympathetic environment, show so light a suicide-rate. Liberty is essentially disruptive, be it expressed in thought or social institution: the parasite has always the sheltering host.

Again, suicide, for reasons akin to those that we have already considered, is much less common in family circles than in the case of the isolated life. Careful statistical study once more proves how family life acts as a determining factor in social integration, especially in the presence of children in a family. Suicide is, in fact, a social phenomenon that obeys laws of its own—laws that sometimes run counter to those that govern the individual life, as in the proved correlation between periods of commercial prosperity and increase in the suicide-rate, or the restraining and integrating effect of crises and their awakening of responsibility in the national life. In short, suicide, in Chatterton-Hill's words, is "directly dependent for its decrease or increase on the greater or lesser integration of society."²

If, now, we seek to inquire along what lines social evolution is actually proceeding, consciously or unconsciously, in relation to such matters, we find a curiously

¹ These, and the following figures are taken from G. Chatterton-Hill's *Heredity and Selection in Sociology*

² *Op cit* p. 218

contradictory result. It will be noted that endeavours to reduce the infant mortality amongst the working classes are being attended with marked success, and satisfaction may also be found in our present system of free education, supplemented latterly by free meals for school children, and even the conveyance of invalid children to schools. To no one of these activities will the philanthropist object. The only question is to what degree, if at all, they constitute alone a real solution of the problem of which they are a phase. It is not enough to regard the feeding of hungry children, and the assistance of those who are handicapped, as present pitiable necessities, the time has come to institute inquiry into the conditions under which such necessities arise. The difficulty is that, almost immediately, the inquirer is made to feel that the whole problem is intimately associated with that of the liberty of the individual, any imagined infringement of which is at once viewed with suspicion. The liberty of the individual has, however, in this country simply become a fetish, upon whose altar thousands of lives are annually sacrificed. In the name of an already surrendered liberty, the best redemptive racial and individual endeavour is consistently opposed.

There can be little doubt that in proportion as the State takes upon itself the education, upkeep, and supervision of the child, it tends in that degree to give doubtful encouragement towards increasing the birth-rate of the least physically capable elements of the community, and to lessen the sense of parental responsibility in quarters where it is often slightly enough developed.¹ It may even destroy one of the strongest parental incentives to labour, and it tends to have a deadening, if not an alienating, influence on all those filial affections that are a stimulus to virtuous devotion. The cry for a higher birth-rate ought to apply strictly to desirables.

¹ "The Coroner (to a witness at Southwark to-day) How many children has your wife had? Witness Well, about fourteen. The Coroner You say 'about' Can't you remember the exact number? Witness Well, she has had so many I can't remember. The Coroner My officer puts it down at sixteen. Is that about right? Witness Yes sir, about sixteen. Another witness stated that the correct number was sixteen."—*Westminster Gazette*, January 27, 1911

The death-rate for England and Wales during 1910 was 13.5 per 1000 as against 21.7 in 1851-1855 this was the lowest on record up to that year. The reduction was mainly due, however, to a conspicuous fall in the infantile death-rate. Under the improved conditions it is the less fit forms that benefit more than the fit. Where, as the result of modern appliances and greater efficiency, it is found that infant mortality, as *e.g.* in tuberculosis, has been very greatly reduced, we yet find that the death-rate tends to increase in the case of males of forty-five years and upwards. That is to say, by our increased care we are permitting the survival and multiplication of the individuals that will probably reduce the racial efficiency, while it appears that those in the best years of manhood are dying at that period at an increasing rate. The very humanitarianism of some of the tendencies embodied in present-day legislation conceals very real dangers to racial progress. The probability is that while immediately reducing suffering, they will in reality increase it for the generations to come. It is the sickly and predisposed that have benefited out of all proportion by recent hygienic advance and civilisation, thus increasing the keenness of the struggle for the more fit. Our vaunted saving of life does not affect the best life, and means a growth and increase of the feebler, weaker life. It is not the expansive elements or individuals in the national life that are assisted.

To strive to find out the conditions of this organic fitness, which is prior to social progress, is not to appear in the guise of an ogre, or because of obvious defects to advocate a return to Spartan ideals. But it is to suggest that, as the sense of national solidarity and responsibility grows, and the feeling of duty towards the future takes more definite shape as a national and religious ideal, we shall realise the necessity of being not less humanitarian but more providently so, in such a way that our care for the race will enter into our care of the individual, and physical weakness be prevented from reproducing itself in forms that can only be a menace to national life, and pain and suffering to the individual life. Whatever hinders that expansiveness,

which is the secret of progress, is treachery to human life. If we do not allow Natural Selection to act on the rapidly increasing undesirable elements of population for their elimination—and this would be contrary to every instinct of higher civilisation—then the only other alternative is to control that multiplication. The work of combating drink and disease, indeed of all physical and moral redemption, is largely lost on the race, and has to be done over again afresh for each generation, if no effort is made at the same time to check the multiplication of long proven strains of biologically and morally degenerate individuals. The Weismannian doctrine of the unchanged and unchangeable germ plasm, inadmissible in great measure as we believe it to be, may yet serve to remind us that the moral individual change may not easily or quickly affect the degenerate constitution. This, however, is certain, that any effect that training and education—however beneficial to the individual—may have upon the stock itself, is largely nullified so long as we shrink from the duty of considering and dealing with the conditions under which in so many instances that stock is being maintained. Bernard Shaw's most modest claim, perhaps, would be that of a serious writer, yet in the Dedicatory Epistle in *Man and Superman* there is this arresting passage: "Promiscuous breeding has produced a weakness of character that is too timid to face the full stringency of a thoroughly competitive struggle for existence and too lazy and petty to organise the commonwealth co-operatively. Being cowards, we defeat Natural Selection under cover of philanthropy; being sluggards, we neglect artificial selection under cover of delicacy and morality."¹ In Christianity there is fortunately a proven method for the production of the individual superman, but none the less the day is not far distant when in the name of posterity, if not of the kingdom of God, the State will have to step in² to prevent the perpetuation of undesirable strains of heredity that

¹ P. xxiv

² As has already been done in some fifteen of the United States of America

have been known to exist in a "pure" form for several generations. Altruism as advisedly practised is a very difficult undertaking. Very easily it may do ultimate harm in excess of immediate good. "Charity," says a French writer, in a slightly different connection, "causes half the suffering she relieves, but she cannot relieve half the suffering she has caused." At present altruism tends to turn the edge of Natural Selection, but makes no corresponding control movement, with the result that it is inevitably causing an increase of the physically degenerate elements in society. We change the environment for the better, but put no check at all upon the propagation of the sociologically undesirable. A more discerning altruism will proceed to devise means of controlling the reproduction of the imbecile and organically diseased, as also of those elements that show no foresight or sense of responsibility in matters that so gravely concern the national well-being.

Its first endeavour will be to collect data, to learn where our legions of insane, feeble-minded, deaf-mutes, paupers, and criminals come from, to keep these strains of human life in their own channel, and consider how they may be checked. We have become so used to these conditions that we tend to think of them as necessary, instead of realising that the divine indulgence given to "times of ignorance" ceases when knowledge has been granted to men. It is possible to proceed along two lines: either by segregation, and elimination of the possibility of the mating and reproduction of the unfit and undesirable, or by the direct encouragement of that which may be considered desirable. The former alternative will preferably appeal to the eugenic mind, for while we know pretty clearly, at least in a few extreme cases, particularly of disease, what is unfit, undesirable, degenerate, it is not so easy to decide what qualities may be useful to society, or in what proportions they should be encouraged. And further, in extreme cases, as Bateson indicates,¹ "unfitness is comparatively definite in its genetic causation, and can, not unfrequently, be recognised as due to the presence

¹ W. Bateson, *Mendel's Principles of Heredity*, p. 305

of a simple genetic factor", while, on the other hand, the higher physical and mental capacities seem to be the resultant of numerous factors whose analysis or synthesis defies our powers

In the case of genetic variations of such differing gravity as cataract, colour-blindness, epilepsy, and feeble-mindedness which cannot be trained into normality, an instinct of parsimony will repress any idea of attempting the hopeless task of their elimination by intermarriage with more healthy stock. On the contrary, "by discouraging imprudent marriages and absolutely barring those of persons of proved feeble-mindedness, we can at least diminish the production in the future of feeble-minded children"¹ Segregation in farm or industrial colonies, apart from the ordinary community, commends itself to modern medical thought as the proper means of dealing with the majority of such cases, "for otherwise there is always the risk (too obvious in the experience of our maternity wards and Magdalen homes) of the production of illegitimate progeny. Experience shows that the inmates of such colonies as have been already established live happy, useful lives to the extent of their capacity, and although there may be need of increased legal power of detention in certain cases, the majority show no inclination to leave the tactful and loving care provided for them. But many more colonies are required, and inasmuch as the money spent on them would diminish the cost of gaols, workhouses, inebriate and other institutions into which the unprotected feeble-minded drift, society would not in the long run be as much out of pocket by the change proposed as might be anticipated"² To such industrial colonies could be attached the residential schools that seem to be more and more called for in the case of the increasing numbers of children medically certified as defective, and requiring special education. Previous to all such realisation, however, must be the shaping of an ideal of greater social integration, in virtue of which the present generation will become

¹ Dr G E Shuttleworth, *Report of the Church Congress*, 1910, p 150

² Dr G E Shuttleworth, *op cit* pp 150-151

alive to its responsibility to generations yet unborn. Such an ideal must ultimately involve a spiritual conception and interpretation of Nature. For it is fact of history that where no supra-rational transcendent sanction is recognised, human nature is unable in itself to subordinate its individual temporal proclivities in the interests of future generations, and only those communities in which a definitely spiritual outlook on the world is fostered, have been proved to be possessed of the elements necessary for social survival.

Heredity and Responsibility

There remains the perennial difficulty of reconciling the apparently exclusive principles of personal responsibility and the transmissibility of qualities from parent to child. With the Weismannian denial of the transmission of acquired characters, responsibility would remain with the individual. He in large measure is "the master of his fate." He cannot blame a previous generation for his own shortcomings, nor can he transmit his failings to posterity. Brain cells may be trained, but not germ-cells, and provided the adequate environment be supplied, under its differential stimulus certain qualities are literally "led forth" or educed, while other potentialities are repressed. This would make the individual's desirable development dependent on his getting into the best environment, while it would lay upon the community the burden of seeing that the handicaps of Nature are compensated for by a superior quality of Nurture. The Weismannian doctrine is, however, far from admitting of sufficiently decisive demonstration to warrant any particular line of progress or moral education being grounded upon it, while in proportion as men come to realise the solidarity of the race, any tendency to fix the responsibility elsewhere than on the individual will take the form of a growing feeling, that "not a murderer is hung, not a daughter starts on her downward career, but a great company, like those who were present at the stoning of Stephen,

stand by consenting to the ruin,"¹—his immediate ancestors, perhaps, but also those who encouraged him in the development of his evil tendencies, or complacently permitted the survival of the conditions in which these tendencies flourished

The deeper question is whether there is such a thing as personal responsibility at all, for the assertion of it involves the assumption of the freedom of the will. Yet upon this assumption society is founded, remorse, the feeling that a man might have done otherwise, seems inexplicable on any other view. An estimate of moral actions is possible only on the condition that they are the expression of a man's free will. Now in Science there is strictly no warrant for determinism. Her statements are all conditional. They take the general form that under such and such conditions certain results will follow. They do not state that these conditions will or must occur. And human freedom is a growing thing, indeed the whole evolutionary process is susceptible of interpretation as the winning of freedom.² As Conklin rightly says, "the alternatives are not merely freedom or determinism, but rather freedom *and* determinism."³ For the study of heredity shows that each individual is a bundle of possibilities, predetermined in the germ-cell it is true, but yet of incalculably wide range. The actual personality that he becomes depends in greatest measure on himself and the environment. It is impossible to deny the existence of a high degree of determination in human life, but to refuse to admit the existence of a certain core of personality where the determination is not so fixed in expression, where a certain plasticity is recognisable, and where that creative consciousness, which is the sole dynamic reality in all phenomena, can initiate action and regulate behaviour in the light of past experience, is to deny a statement relative to the will in name of a physical category of causation which after all is ultimately derived from the will itself.

Heredity may modify and condition responsibility

¹ Amory Bradford, *Heredity and Christian Problems*, p. 202

² Cf. *Man and the Attainment of Immortality*, chap. xi

³ *Heredity and Environment*, p. 327

it cannot destroy or disannul it in the normal individual. A man is not necessarily responsible for the circumstance that certain possessions were bequeathed to him, but in so far as they are his possessions he is responsible for the use he makes of them. Where inheritance and heir are one, the conditions are not otherwise. "Behold, all souls are mine, as the soul of the father, so also the soul of the son is mine. The soul that sinneth, *it* shall die"¹. At the same time heredity introduces shades of responsibility so subtle and delicate, that the more we study men as we see them around us, the more impossible it appears for us to be able to judge any man, the more we feel that God alone can judge righteously.

¹ Ezek xviii 4

CHAPTER X

ENVIRONMENT

THAN Environment, in the broadest sense of that term, no factor in Evolution is more important. Under this category we may include the stimulation *eg* of food, of climate, of injury, and of use and disuse, on the assumed transmissibility of the results of whose play upon the organism, the Lamarckian explanation of Evolution was based. If an organ or cell of the body is under consideration, then the rest of the body and its secretions will be primary elements in the environment of that particular organ or cell. Important in the case of the individual life-history, it is not easy, in face of the uncertainty regarding the transmissibility of the results of such stimulation, to estimate their value in the racial history. Certainly in the vegetable kingdom active use and disuse can have played no part. We cannot suppose that the facts of hair distribution in man are explained on the supposition that he "used" the hair of his head more than that on his anthropoid back. No organ is more used than the tongue, but there is no increment of use-inheritance. If the environment influences the individual through the germ-cell, and the results are transmissible, we should expect a progressive degeneration in the case of forms inhabiting unfavourable environments. But the facts hardly bear this out. We may have a repetition in successive generations of pale-faced stuntedness in slum-bred children, but it does not progress to any such marked extent as would be the logical outcome of the acquired character theory. Nature does not move so quickly as all that. Throughout the Middle Ages almost till modern times, the Jewish people were confined to the slums of the cities

where they dwelt, but the Ghetto characteristics do not include progressive physical degeneration

The fact that the seeming inherited effects of these aspects of environmental influence may be otherwise explained in almost every case, adds a sense of suspicion to the too easy Lamarckian interpretation. On the other hand, there is experimental work¹ suggesting that some measure of truth—as yet, however, incapable of clear definition—corresponds to the general belief that the individual can to some extent permanently modify its ancestral patrimony, and that the effects of the environment may under certain special conditions be, so to speak, more than skin deep. There is little, if any, unequivocal proof that a specific acquired variation is exactly reproduced in the succeeding generation by direct transmission, but this does not necessarily mean that the gain or loss of the individual is without any effect on his offspring. Darwin, in his earlier days, was inclined to treat the Lamarckian factors with scant respect. Later, his views were modified. In 1876—two years after the appearance of the second edition of *The Descent of Man*—he wrote “In my opinion the greatest error which I have committed has been not allowing sufficient weight to the direct action of the environment, *i e* food, climate, etc., independently of natural selection”²

How much it is necessary to take the environment into account at every moment in considering the development of any form, is shown, *e g*, by Herbst's experiments on the egg of the sea-urchin. When certain components of the salt water were replaced by other chemical substances, the structure of the larva differed profoundly from that developed under the normal condition³. A wealth of experimental research shows to what a large degree the course of development may be modified by external causes, operating especially during the earliest stages of ontogeny. In fact, it is only in studying the abnormal environment and its results that we realise the persistent effect of the normal environ-

¹ Cf p 172

² *Life and Letters* vol iii p 159

³ *Archiv Entwickl Mech* 17 1904

ment The study of the living organism in its environment is the study of two variables, their interaction produces the specific results that we see In the case of the lower organisms, this environment, wholly physical in character, almost completely determines their life According to their success or failure in adaptation, do they survive or perish It will appear that, ultimately, the environment, both physically and spiritually conceived, is the more enduring element, nevertheless it also changes, and although these changes are slower and not usually on so marked a scale as the changes in the organism, it can still be shown that there is a marked correlation between such change and critical moments in the evolution of life, as at the close of the Carboniferous Era, when reduction of the amount of carbon dioxide in the atmosphere by the vegetation, combined with elevation of the land surfaces, prepared the way for a new advance To every change in the environment there is a corresponding change in the organism

Experimental work (*e g* that of W L Tower on Chrysomelid beetles of the genus *Leptinotarsa*¹) has also, however, been conducted with a view to determining the precise relation of environmental stimuli and changes to the production of variations Some very striking results have been reached, proving the direct influence of environmental stimuli—changes, *e g*, in temperature, food, light, etc—in disturbing directly the equilibrium of germ cells, and so inducing marked variation in the next generation, while the immediate effects of the environment in bringing about change in the individual—those changes that are of the nature of adjustments—is the initial observation of biology Even from the Weismannian point of view, adjustments or adaptations are effected by the selection of genetic variations The selecting agency is none other than the environment, or more accurately, the organism is at every moment reacting to the environment—a reaction different from the passive reaction of the stone to a kick—a reaction which in the end is of the nature of life or death usually before the period of reproduction,

¹ Pub No 48, Carnegie Institution of Washington, 1907

and the final result of which, at any moment, is selection or rejection. In every way new characters depend upon the environment—both for origination and for perpetuation. How, exactly, the stimulus acts we do not know, nor can we in any marked degree predict the character of the variation. But that the environment causes variation in an orderly and broad-schemed manner there is no doubt. In short, the ultimate cause of variation lies in the environment, whether its action is direct or indirect.

With regard to man, we have already definitely committed ourselves to the position that environment has the last word. In his case so little depends comparatively in the normal individual upon the inborn capacity and so much upon the actual acquirements, that the environment means more to him than it does to any other creature. If, in what concerns him, heredity counts for no more or no less than it does in the case of the lower organisms, environment counts for very much more, just because he is a social and intelligent being who can therefore enter into a deeper and wider range of commerce with it, controlling it in part, making it, and allowing himself to be made by it. His relation to it is a growing relation. And we do well to bear in mind the importance of this factor in the individual life, always present, always varied, counting just because of its constant pressure.

"There was a child went forth every day,
And the first object he looked upon, that object he became,
And that object became part of him for the day or a certain part
of the day or for many years or stretching cycles of years
The early lilacs became part of this child,
And grass and white and red morning-glories and white and red
clover, and the song of the phœbe-bird"¹ etc

Yet already in the higher animals, and certainly in man, the influence of organism upon organism counts for more than the inorganic environment—those subtle interactions that are the result of the web of life, like the unhappy effects produced by parasites upon their hosts, the insect galls on plants and trees, the influence of the various forms and classes of society upon its

¹ Walt Whitman, *Assimilations*

members Here the effect of the environment is not as a rule immediate its influence is chiefly felt in modifying the action of the individual, in stimulating, limiting, or diminishing its functional activity Accordingly we must expand our conception of the environment beyond these three-dimensional aspects with which we usually associate it, when considering it in its relation to the humbler forms of life We must include not merely its physical but its psychical aspects There is no doubt that, in addition to relations with the inorganic aspects of the environment, the members of early protozoan colonial forms were in direct or indirect physical contact with one another by connecting filaments (*e g* linin elements of the reticulum)¹ or otherwise, by which means not merely were greater unity and compactness of social life brought about as the response made by individual members to particular stimuli was communicated to other members, but the condition of some members exerted a direct influence upon others In some such way does the individual cell in all higher organisms become aware of the responses to environmental tendencies and stimuli given by other cells, until centralisation and unity of response result The process of co-ordinating and centralising the differing reports on the environment made by the units of an organic colonial form is strictly paralleled by the development in the central nervous system When we reach the stage of man, while this direct physical contact normally ceases, nothing is more clear or strong than the environmental influence of his fellows It may appear with the physical element strongly marked, as in the mutual effect upon one another of mother and child, although even here the influence is disparate—the desire of the child for its mother being more physical than psychical, that of the mother for the child more psychical than physical,² but we quickly reach cases where, although doubtless there still is nervous stimulation, the principal activity seems to be in another dimension, and the influence of mind

¹ Cf p 67

² Cf H M Bernard, *Some Neglected Factors in Evolution* p 390

upon mind or feeling upon feeling may be exerted altogether apart from sight or sound or touch. This psychical zone of the environment means more to man than any other. The communication between its elements has usually been considered to be indirect in character, as by signs and gestures, and in close relation with physical phenomena, but it appears increasingly probable that the psychical impulses or contacts may be also direct (telepathic)¹

Towards the reality of this subtler psychical aspect of the environment it is difficult to maintain an attitude of doubt. As the result of its stimuli the individual mind develops, the individual's feelings are awakened. It is true that in this zone the three-dimensional tests are unavailing—we cannot calculate the horse-power of hate nor take the specific gravity of love—yet our perceptions of the psychical and of the physical zones are ultimately alike in being states of consciousness, affections of some discerning principle associated with the central nervous system. With the five senses man is magnificently equipped for his exploration of the physical zone of the environment, and for this psychical zone—where in our perfect development “we shall know even as we are known”—man seems to be equipped as a definitely spiritual personality, whose evolution is really only now beginning. Concerning the relation to the body of the percipient integrating controlling spirit that is something more than the sum of its powers of perception of the physical and psychical forces of the environment, various views have been held. Without examining them we may consider the genetic character of this “spirit,” and its relation to the environment.

We have seen that the fundamental similarities in racial, national, even occupational mental character point to the basal rôle of heredity. Further, the inexpressibly slow rate of evolution is only to be accounted

¹ Cf. Prof. C. Richet, “The Channels of Knowledge outside the Senses” (*Proc. 11th International Physiological Congress*, 1923) where he gives his reasons for believing that there are, for the knowledge of reality, other channels than the sensory and normal ones, in short, “a hidden sensibility,” which he designates “cryptesthesia.”

for on the same understanding Tremendously conditioned by physical heredity, the individual moves along in the racial stream of human life, developing from the outset an integrating controlling self, responsive at once to the traditional psychical aspect of the environment, yet with the power to enter into relationship with that which seems to be most spiritual and ultimate in that environment Change in the physical environment helps to initiate change in the physical nature of the organism This physical dress certainly is handed on in direct continuity from one generation to another, but the *node*, the specific spiritual centre of combination of the elements of personality is only developed at self-consciousness, and is thereafter persistent in a greater degree than any element that it combines Its constituents are largely, perhaps all, hereditary, but the particular integrated expression, or unity of experience, is no hereditary thing It is a unique creation—not a duplicate, it is a living soul The physical stream shows continuity, but those individuals rising out of it, with their wide range of variety and distinctiveness that mean more in life and action than the common basal heredity, are strictly in no genetic relation The lower ranges of mentality doubtless are subject to hereditary transmission, as we have seen ¹ we are aware of primary instincts and feelings, mental associations, and specific responses that are common to men and reappear generation after generation, thus suggesting definite transmission Nevertheless, there remains that which is not within the process in quite the same sense as the rest, for it comprehends the process and is akin to that which is at the core of it all This conception of spiritual personality, as that which controls those lower ranges, and is something distinctive and originative in action and thought—a kind of receiver and transmitter in one, a coherer in short—does not fit itself into the ordinary ideas of hereditary mechanics Consciousness, particularly in its highest sweep of self-consciousness, forward-looking and conative, is not something that is explicable in terms of any simpler antecedents merely It is unin-

¹ Cf p 179

telligible apart from that greater and perfect Consciousness which affords a partial expression of itself in the less, and in varying degrees in other phenomena of Nature, which pervades the environment, and out of it works itself up and into the being of the lesser expressions of it, as a creative and energising force. It is because personalities crystallise out of this great stream of human life that it behoves us to do what we can towards its eugenic improvement. The naturalistic and the religious view, each of them, expresses a truth, and it is no help sharply to oppose them. Certainly man is becoming, rather than has, a soul, and once he has reached the level of self-consciousness he is able through his spirit to come into communion with the Spirit that informs the whole process of which he is but a part. He is of it, and yet not of it: for a period, his incubation period as it were, the environment acts as his nurse in its purely physical and proximate aspects, but a stage comes when he is able to penetrate past that which is proximate and immediate to the deeper Reality in which everything consists.

How, then, shall we ultimately think of the environment? In its widest sense we may apply the term to everything that is external to the living being. But it is only the informing energies there that actively affect it. We have already realised how any particular stage of development is the resultant of the effect of the environment upon the preceding stage of the organism. As life advances, the successively higher forms come into deeper and more intensive correspondence with an increasing number of elements in the environment. Evolution essentially involves the progressive development of the means of adjustment of the organism to the environment. The criterion of advance is the scale of correspondence with the environment in that lies fulness of life. Evolution is not merely an unfolding from within, it is an infolding from without.¹ And that which is taken in at one stage, energising within the individual, prepares it for a yet wider, more subtle, and more intimate relation with the environ-

¹ Cf H. Drummond, *The Ascent of Man*, p. 414

ment But this, in its proximate physical aspects, is very simple for the simple forms of life The protozoon is in minimal correspondence with its environment Not merely is its range of activity very limited spatially, temporally, and in diversity, but the isolation of its life in relation to its fellows is almost complete The protozoon and the fish are literally in the same environment, yet how different the environment is to the fish by reason of its wider range of commerce Its eye involves a greater acquaintance with the environment than can be gained by the diffuse phototactism of the protozoon

Now, the progressive evolution of the eye may be traced through various stages from *Paramœcium* with its diffuse, positive phototactism, through *Euglena* with its eye-spot, up to the vertebrate eye, with its fine capacities for appreciating form and colour The objective cause of light was there, however, all along, though but dimly sensed by the lowest forms Not otherwise could living organisms have become aware of and responded to the light demands of their environment by the formation of an eye Even in the development of this single sense there has been a growth in the range of experience, each stage marked by illusions which were corrected by further advance, each stage conceivably characterised by a certain agnosticism with regard to any subsequent stage "New organs do not develop unless there is a function for them to discharge connected with a correlated external condition"¹ It is from the environment that the inflow and stimulating summons originate, and each new relationship between the progressing organism and the environment makes that same old environment appear something different and new When we consider the racial history we may even notice a grading in the different dominant types that were successively produced as the resultant of its action—a definite character in the successive conformities that meant survival—powers of assimilation, muscle, then mental ability, unselfishness and social virtue, spirituality, until finally the environment in its

¹ Prof A Macalister, *Expositor*, January 1910

deepest and most spiritual aspect, working in and through mankind, seems to take the guise of a "power, not ourselves, making for righteousness." Again, in the case of the ear, we can trace its relationship to different elements (water in the case of fishes, air in the case of terrestrial forms) in response to whose vibrations it has developed. In like manner there is a distinctive adaptation of the tongue, nose, and fingers to physical aspects of the environment. But all our knowledge of these elements will not help us when we strive to understand the eye. Accordingly we must seek another element—the ether, subtler far than those under whose influence the other senses were evolved—before we unravel the correspondence here, and we become aware of the ethereal environment which, mayhap, is not discontinuous with the environment of more material things, and through which man gains a new view of the cosmos. Interpreting the environment in terms of the ether means something more generalised and profound. Yet life and thought itself, in the citadel of this outreaching being, are not explained by reference to the material environment or the ethereal undulations. Light is not explicable by the material environment alone; still less can life and thought be interpreted by the material and ethereal environments alone. The grossly material environment does not exhaust man's possibilities; he evidently responds to, or is influenced by, something more than the things he touches, tastes, and smells. So we are driven to believe that in relation with the environment must be some other element, "metethereal," akin to thought and righteousness, akin to that which it has persistently produced of lofty moral and religious idealism in the noblest of men, akin to those characters that it has progressively demanded in living beings as the condition of survival. At any rate, we cannot conceive of the environment as merely mechanical and physical. There must be that which is spiritual and righteous about it. Indeed, in its most intimate and ultimate manifestation, shall we call the environment "it" or "Him"? Can there be anything less or lower in the cause than there is in the effect?

Have we not here to do with Him in "whom we live and move and have our being?"

For, when, finally, we consider that man *is* a religious animal, we find it difficult to believe that there is nothing in the environment that elicits that particular characteristic. Has not the human mind since the beginning been aware of some greater yet subtler spiritual character in the environment than that which is merely found in the psychical zone of his fellows' minds? How else shall we explain those potentialities in every man, wrought into the fibre of the race through its past experience, initially developing now, like the elements of the embryonic eye, no longer under the original stimulus, yet able to respond to it directly they are placed under its influence? As little can we believe that the eye was developed without the play of the ether waves as that the religious faculty was developed without thrills and pulses of some corresponding Reality in the environment. Perhaps the Coelenterate hydra, if self-conscious, would have worshipped a glorified stomach, and the worm a glorified muscular force,¹—and some men still hold such objects of worship in reverence, but they are human reversions. We must judge by the highest and the best. Nor does it follow that, as in the growing revelation ever higher features are later discerned in the environment, those that are earlier or lower absolutely disappear. The son of a king may know his father first as love and kindness, and later realise that he is a statesman, and a king all-wise and powerful, yet does not cease to think of him as love and tenderness. Henceforward, however, man's development will be spiritual, and so we are compelled to believe in a spiritual cause in the environment that was aware of an end from the beginning, towards which it has all along been working. Man's further progress depends on conformity to this spiritual environment, *i.e.* in becoming like it, and he can consciously conform. The interplay, the unfolding and infolding, are there all along by mutual reaction the

¹ Cf J M Tyler *The Whence and the Whither of Man*, p 160, from whose pages much assistance in the presentation in this paragraph has been derived.

relation is strengthened. But conformity to what is deepest and best, conformity to those realities that are unseen and eternal, means nonconformity to some of the lower, more palpable and proximate elements of the environment. It means, in addition, conformity or obedience to the laws of the individual's innermost structure and higher being. It involves deliberate surrender to the influences of the spiritual environment, that mutual interaction of the human mind with the eternal Mind under which arise those visions of ideals yet to be achieved, ideals of social and individual worth, the ideal of the kingdom of God. By reflection on these, the individual, under the developing influence of the informing Spirit, becomes "persuaded" of them, and his life becomes a life of devotion to them, until in it they become luminous to his fellow-men. Inevitably through the inertia of the material, and the self-absorption of the present, their realisation will be pushed out into the future. But these are the men who are holding and shaping the future, while those of the bounded horizon, who are engrossed with the present, completely adapting themselves to it, must perish with it. To walk by sight, conforming to the palpable, is superficiality of life. Even that cannot be done without a measure of faith, although the man may not be aware of it in his spiritually unconscious existence. He only is alive who lives consciously by faith, a faith that holds the future just as surely as it understands the present. St. Paul states the law, "Be not conformed to this world, but be ye transformed (*μεταμορφοῦσθε*) by the renewing of your mind, that ye may prove what is that good, and acceptable, and perfect will of God"¹. Within limits the law holds true for the lower creation, it was the rule of progress even in the Silurian days. The mollusc conformed to the most obvious and proximate elements in its environment, and progress ceased for it. It lived a life of ease—food there was for it in plenty in the slime, and in assimilation and reproduction its whole life consisted. But the ancestral vertebrate, forced into an active swimming life because of the competition with

¹ Rom. xii. 2

the gigantic shell-clad *Orthoceras*, conformed in another way, and was transformed, lit metamorphosed, into something higher¹ A certain measure of conformity is necessary to secure that survival without which there can be no possibility of progress, yet the persistent temptation is to conform so completely to the proximate elements of the momentary environment that there is no possibility of permanent survival, still less of advance. It is admitted that the unmasking of this ultimate Environment is very gradual, that even yet man is not fully aware of God, and cannot comprehend Him in His infinity. In this direction, however, it seems perfectly clear that the further evolution of man must take place if he is to progress, for he is most sharply distinguished from the forms immediately below him by his moral and religious characteristics, and these are most highly developed amongst the most civilised peoples. True, that progress is very slow, and the great majority of men are not even aware of its direction, being content with conformity merely to the physical elements in the environment. But as the sensitive photographic plate, steadily and long exposed, reveals what human eye has never seen, even with the telescope, of the farthest and deepest heaven, so in the human soul set steadily towards the spiritual environment, will there be, mirrored and eventually developed something in revelation of the personal God so dimly seen in the immediate physical environment. Or, best of all, in the face of Jesus Christ, whose correspondence with God was perfect, and in whose mind were focused rays of truth from that spiritual Environment, which have proved a revelation to man, shall we see the clearest reflection of the Divine Glory. To dwell in such complete and perfect correspondence as was His with the Ultimate Environment, which is God—that is heaven.

¹ J. M. Tyler, *op cit* p 200

CHAPTER XI

THE DIRECTIVE FACTOR IN EVOLUTION

OF the world process as a whole, it will be agreed that our finite minds with their limited ancillary appliances can form no adequate conception. Quite apart from all ideas of development, the modern account of the proper motion of the stars, for example, raises the question of direction in a bewildering way. In an epoch-making paper on star-streaming,¹ Kapteyn gave evidence for believing that two apparent directions of motion predominate in the stellar world, and that the two star-streams which comprise the stellar universe as known to us, must be moving in diametrically opposite directions. He adds "In order to prevent misconception, however, it will be well to state expressly that the existence of two main stream-lines does not imply that the real motions of the stars are all exclusively directed to either of the two vertices (*i.e.* the points of the sphere towards which the star-streams seem to be directed), there is only a decided *preference* for these directions. *All the stars, without exception, belong to one of the two streams*."

The fact of these two apparently aimless star-drifts moving past and through one another in opposite directions through space, has been seized upon as evidence of the purposelessness of the universe. So also might a mayfly, released one sunny Saturday afternoon from the prison of its lower life in the quiet of a canal hard by some city, notice two streams of human beings passing in opposite directions along some highway, the one from the country into the city, empty-handed yet

¹ *Brit Assoc Report* 1905 p 257. Subsequent confirmation has been given by Eddington and Dyson

pensive, to purchase their week-end needs, the other passing from the city, buoyant though heavily laden, to picnic in the fields. And if, towards the close of the day, as the mayfly's life ebbed with the withdrawal of the sun's rays, it noticed a reversal in these movements, as the country-people laden with their stores moved out again with gladness towards their homes, while the townspeople, their outing ended, moved unburdened yet subdued towards the city again, its philosophy of human existence might well be that though there was a certain background of permanent stability, yet life consisted in drifts in two opposite directions which after a time slowed down, ceased, and then recommenced in the reverse directions, accompanied by a certain redistribution of matter and apparent change of energy. What could the mayfly learn of human purpose? Brief as the love-dance of the mayfly in the sun is the life of man compared with the process of the ages the human ephemerid is aware of movement, redistribution of matter, and transformation of energy, and too often he writes it down as aimless and purposeless. Much current philosophy is on a par with the mayfly's.

However we may seek to decide the issue as to directivity, it must to-day take its place in an evolutionary scheme. This at once prevents us going out into the world, there to gather ready-made proofs of divinity rather does it show us a world that is becoming divine. Between the watch and the flower¹ there is this further enormous difference that, while the former is so little in itself—so easily compassed in understanding in its entirety—that the Paleyan mind goes off in speculative questioning about the maker, the latter is so inexhaustible that inquiry takes the form, What is it? But to answer this, as Tennyson rightly perceived, is to understand all about not merely the flower, but the Whole to which it is related. Not merely the watch and the stone but the baneful insect under the stone, and the thief who dropped the stolen watch as he ran, would all have had to be examined in the same narrow

¹ See p. 107

way, with varying result. This Paleyan method of calling isolated witness could never demonstrate Paley's preconceived God, unless with careful selection of the witnesses. The vital question is, What are the character and testimony of the Whole? To ask this question is, however, to rescue the conception of design from the stiff, calculating, carpenter-like method of the Paleyan mind, it is to surrender the conception of a predetermined programme of creation, every detail of which is knowable in advance and specifically planned, and to substitute in its place the thought of an energising Principle or Ground which works persistently and reasonably, yet spontaneously, and which gradually realises an aim whose tendency is, at any rate in part, perceptible to finite minds. The older conception still remains with us in part, because human life exists under the conditions of a time process, but it is inapplicable to a God whose creative activity is continuous and timeless.

With regard to the cosmic process, as a whole, then, we cannot agree with any certainty. How could we indicate purpose in the heavens? They bear the marks of intelligence, but we may well believe that the purpose is too great for us to understand. Perhaps the modern study of astronomy shows us more and more of intelligence, and less and less of purpose such as we can yet comprehend. When we consider the heat and light radiating from our sun in such endless profusion to all points of the universal compass, our finite minds tend to ask, To what purpose is this waste? The Mosaic cosmology tells how God "made the two great lights, the greater light to rule the day, and the lesser light to rule the night," but at that point the sacred writer's perception of a purpose seems to halt, and he simply adds, "He made the stars also."¹ Accordingly we shall limit the inquiry for the present to the realm of the organic and the inorganic as we know them on that planet which, if not *the* centre of the uni-

¹ Gen. 1. 16. It is perhaps only fair to state that the Old Testament critic considers the words "He made the stars also" to be a gloss (cf. Skinner, *Commentary on Genesis, in loc.*),—which illustrates the difficulties of Biblical interpretation.

verse, is at any rate *our* centre, whose history is our history. What is true of the part may not be true of the whole, but it is something to be sure of the character of the part that we do know. The question is, whether the process, as we know it, betrays purpose, guidance, direction?

So far as the denial of this is sometimes indirectly based on the supposed findings of scientific research, it is not merely necessary to realise that her account of phenomena is not merely an incomplete account, but that the strictly scientific account often contains implicit within it more than the expositor realised or even in some cases intended or desired. Indeed, in these respects he is often hoist with his own petard. For example, if we consider for a moment the famous Spencerian formula, "Evolution is a passage of matter from an indefinite incoherent homogeneity to a definite coherent heterogeneity," not merely do we never get any actual passage or specification¹ under it, but even as we think the sequence of stages of this passage backward in their causal relationship, we never reach a stage that is strictly indefinite, as *ex hypothesi* it is sufficiently definite to act as cause to its immediate successor. Further, we never actually get a hint of a homogeneity out of which, even if it did exist, no heterogeneity could arise. The constitution of the all-comprising nebula at any given moment—to take a favourite Spencerian illustration from the inorganic realm—must have been just as specific and definitely organised, as any of the later and more complex phenomena resulting from its transformation and differentiation. To Spencer's mind, matter, wherever it exists in a homogeneous mass, *e.g.* the primal nebula, is of necessity unstable and cannot remain homogeneous. As a matter of fact, inasmuch as we are unaware of matter except in so far as it is allied with energy—the modern physicist interprets one in terms of the other—this primal homogeneity of constitution and relationship is a mere figment of the imagination. In fact, Spencer admits that at whatever point we choose to

¹ Such *e.g.* as you get in connection with every building under the law of gravitation

think of evolution as commencing, that change was necessitated by what went before, and there "remains to be added the conclusion that these changes (thus initiated) must *continue*"¹ Or, in other words, evolution itself is determined by some preceding definite heterogeneity, and all that is developed at any stage was implicit in the preceding stage But this leaves us with the question, which is indeed there at every stage, To what is due that particular heterogeneity, that definite arrangement of matter and energy that at any stage contains implicit within it all that follows? This question Spencer never answers

What, then, is offered to us in the name of some modern philosophy of science is a series apparently now, *sub specie eternitatis*, interminable, *a, b, c, d*, in which we come to think of *a* as the cause of *b*, of *b* as giving rise to *c*, and so on Strictly, however, we do not know that *b* will follow *a* in any particular case we only believe it And, further, the deduction, so frequently made, that all that is in *b* is implicit in *a* and so on, is simply untrue in the case of the developing organism if we consider the letters as representing successive stages in its ontogeny, for at every moment that development is in vital dependence on the environment In short, there is much misuse of the word "cause" Physical cause differs from efficient cause Into the conception of scientific cause enters only the idea that things affect one another in definite ways In a true cause we find an element of volition, and in all creation this is the principal element Nothing, then, of volition enters into natural law *per se*, although in the objective world natural law might be held to be a true cause, volition always being excluded But then in human life volition is the only true cause We may learn perfectly the order of changes, and yet learn nothing as to why they occur in that particular order The infinite regress affords no resting-place for the tired mind it wants to know the character of the creative energy that it perceives to be at work in the world process Looking, however, at the series in its most

¹ *First Principles*, p 429

general form, what we have to try to determine is whether the particular form that the series takes is a matter of chance or of definite direction

That it is matter of chance, as the answer given, *e.g.* by the Haeckelian-Spencerian school, does not bear careful examination. The indefinite tossing of a coin by the unconsciously adjusting and compensating human hand may in accordance with theory result in an equal number of heads and tails thrown by an accurate constant machine, the coin may be compelled to manifest its bias, and it is possible that the succession might be tails *ad infinitum*. All linear series of phenomena, in space of one dimension as it were, are from this point of view mechanical, causal, and sequential. The element of chance is ruled out. Any interplay or striking result arising from the impinging of horizontal series in space of two dimensions, as it were, is a coincidence and due to chance. In 1871 two companies of men began tunnelling towards one another on either side of the St Gothard Pass. ten years later they met. In terms of this philosophy the linear drills were mechanical and causal. the fact that they met was chance. Here, of course, the cause is found ultimately in the mind of the planning and directing engineer. the question is why it should be otherwise in the case of these convergences in Nature that at least wear the guise of ends. On examination, at any rate, it becomes clear that chance in Nature and in pitch and toss, in the life of the animal and of the spirit, does not really exist as such, but is simply a word used to describe that of which the causes are not known to the observer in their entirety, it can never amount to saying that they were not due to purpose—in fact, it includes that possibility.

Science, then, offers us her account of the world process in complex series of sequences, but if we are to be certain in our deductions as to what lies behind the process, if we are to trace backwards each step systematically until we come to that which we may think determined the process, if we are to be effective in our examination of its purposefulness or otherwise, we shall have to be very sure that we are investigating the whole

of the process. If Science can argue back from what is to what has been, and venture to predict what will be from what is, it is essential that she understand fully and completely what is. And it is just here that the doubt is greatest as to her success, and often in direct proportion to the incompleteness of her account is a certain studied disregard and contempt—in itself so contrary to the true scientific spirit—for anything that cannot be fitted into the network of relations and uniformities as known at any definite period in history, as also for any suggestion of implications of a wider nature than those which the surface view of the data affords. It is essential that Science understand fully and completely what is. If any attempt be made *e.g.* at elucidating the evolution of morality or the causes that produce it, then that account must not commence with the morality of the bushmen, but with morality as we know it at its highest and best. Working backwards, the investigating mind will never discover a stage in which there was not active determination and specification, pattern, and power. The scientific mind may break in at any moment with a formula, and state that under certain conditions in terms of that formula the whole world process can be explained. One thing the formula cannot do, *viz.*, explain itself.

If now we consider the question on its positive side, we find our initial reason for believing in the existence of a World Principle or Ground in the simple fact of the unity and intelligibility of the universe. The proof of the unity of the World Ground must start from a system. The universe, we maintain, is such a system. Every thing is what it is, in part because things are as they are in other places. We deduce this by reason: it is not a matter of experience. Science posits a dynamic relation between things. Things determine one another, they interact, we find a law of uniformity of action. These facts make the world an object of knowledge. Nature as a system is a cognitive ideal. And yet the whole creative arch was not sprung at once. Consequently, if one of the elements of the solar system should disappear, it would not mean the collapse of

the system If the moon should disappear, perhaps the tides would be less, the days shorter, the nights darker, otherwise there would be adjustment—an indication of essential unity That the intelligibility of the universe is partial only is nothing to the point, the mere fact that the world process, whether in detail or as a whole, is susceptible of being understood, however imperfectly, seems resolvable only in one of three ways We may suppose that this intelligibility is a chance accompaniment, a sort of epiphenomenon, of what is *ex hypothesi* a non-rational process to believe this involves an irrational reversal of all experience Again, we may maintain, as has often been done, that the intelligibility and so the rationality that man finds in the world process are simply the projection of his own reason into it I do not know if a lunatic's philosophy would interpret the world process as chaotic—a reflection of his disordered mind, if so, it might be difficult to differentiate between the diagnosed lunatic and him who professes to find no objective order in the world process as a whole It may be perfectly true that our minds have to some extent adapted themselves to this universe, and that on such adaptation depends human existence, yet we have the idea of unreason, and we can realise that self-conscious life would not be possible in a universe that was unintelligible to us Finally, we may maintain that the universe is intelligible to us simply because behind and within its phenomenal activity, there is something akin to the human mind To the casual customer the ceaseless vagaries of the telegraphic needle convey no meaning, representing merely "sound and fury signifying nothing," but to the operator they are burdened with significance, yet the moving index reveals even to him no image of his fellow-worker at the other end It simply indicates his mind, and the message is intelligible just because it is an expression of a mind, and the intelligibility implies some sort of a relation between the minds at either end of the wire The analogy is remote, for after all the telegraphic apparatus is but a static vehicle of energy Still the phenomena of Nature, symbols significant of

something which we cannot fully understand with our limited senses, and impotent to give us any measurably complete account of the World Ground itself, are interpretable just because there is this element of Intelligence in it, which has been and is related to our intelligence. In other words, Infinite Mind exists, and is related to our mind.

When, further, we inquire into the character of that intelligibility, we find that it takes the form of Order. We note the qualitative and quantitative adjustment of all things according to law. The ordinances of the world stand fast, the power that supports it, of which it is an expression, shows no variableness, neither shadow that is cast by turning. This sustained order, the fact that the process is intelligible *all along*, seems to involve the conclusion that its continuous meaning must be meant. A momentary intelligibility might not necessarily have implied a creative mind. It is not inconceivable that the indefinitely repeated mechanical sorting of millions of alphabetical letters might sometime produce that particular arrangement of letters and words which men would recognise as *Paracelsus*, but the next arrangement would be complete chaos, and even if, by the ultimate chance, it were not, and *The Pickwick Papers* instead fell out, yet the lack of relationship between it and succeeding and even preceding results, would foil all understanding. Chance is incapable of producing continuity, sustained order is an index of Reason. If the order of Nature which we do find does not involve the existence of God, the disorder which we do not find would have amply disproved the hypothesis.

In any case, the explanation of Nature, even as an unconsciously working mechanism, arbitrary and blind in its groping, is very difficult in face of the fact that it has produced self-consciousness and intelligence in man—the mirror in which she, in a sense, can regard herself. Either we must admit that the scientific examination of the origin of the human reason results in postulating an irrational cause for it—as it might be supposed to do on reduction of that reason to a dance

of atoms—and there we leave the problem, committing ourselves, however, to a gigantic act of faith in assuming the trustworthiness of the scientific reason, and too apt to forget that we are reaching these very conclusions by the self-same faculty of postulated irrational origin, or we must investigate more deeply, seeking the cause of whatever sequences we find—even if they apparently result in the production of the rational from the non-rational—in some rational World Ground whose operations take for us the form of natural laws. The one faculty, we repeat, by which alone man judges natural process was derived in the course of the working of that process, and yet it is maintained that the process shows nothing that is akin to mind, intelligence, or reason in it. This cannot be asserted in so far as it means that the process is less than rational, in so far as it may be taken to mean that the process is informed by some Principle or Ground displaying intelligence vastly superior to the human mind, we come within hailing distance of theistic interpretation.

With the strictly teleological aspect, fresh considerations arise. Particularly in the organic world do we find, to a striking degree, what appear to be instances of anticipatory adaptation. Indeed, adaptability itself almost seems indicative of purpose. In the case of individual development there is not merely suggestion of the past, as in the stranded "erratic" on the mountainside, but anticipation of the future. Where such adaptation is lacking, and mere causal physico-chemical sequences take place in their own narrowly predictable manner, we know that the organism is dead. In the case of organic bodies we see a process pointing to future results—a prophecy of the future, at least an appearance of design. We are not deceived by the crystal, we know how it works and grows, so that this hint of design is not a mere anthropomorphism. In the case of the alum crystal there is no prophecy, simply a present realisation of a present force.

That such a contingency is recognised even by the biologist may be gleaned from his continual references to what is sometimes technically called *orthogenesis*.

The term is used to express the apparent initial pre-determination of lines of variation apart from Natural Selection, which sometimes makes an alluring appeal to the biological mind, and to the palæontologists in particular. It occurs in all degrees, abintrally and abextrally, from Korschinsky's statement that "in order to explain the origin of higher forms out of lower it is necessary to assume in the organism a special tendency towards progress,"¹ to Eimer's sounder views that "variation everywhere takes place in quite definite directions which are few in number," and that "the causes which lead to the formation of new characters in organisms, and in the last result to their evolution, consist essentially in the chemico-physiological interaction between the material composition of the body and external influences."²

For positive evidence of orthogenesis in ontogeny reference may be made to a paper by Bashford Dean,³ in which he states his belief that the adaptation between the embryo and its egg-case in *Chumæra* can only be explained on the basis of determinate modification. The substance of the capsule or egg-case, although "only indirectly connected with the egg, *i.e.*, as a secretion formed by the parent after the mechanism of heredity has already been established in the egg, nevertheless (1) 'foresees' with startling exactness the size and shape of the young fish when many months hence it comes to hatch out, and (2) it provides a series of progressive modifications adapted to the developing physiological needs of the young. It is evident, accordingly, that if natural selection be adduced to explain the present phenomena, it encounters difficulties more numerous and complex than in usual instances. In the latter cases selection concerns itself with variations which affect the progeny directly, but in the present case variations must have occurred in the lines *both*

¹ "Heterogenesis and Evolution," *Naturwiss. Wochenschrift*, vol. xiv pp. 273-278, 1899.

² *Organic Evolution*, p. 4.

³ "Evolution in a Determinate Line, as illustrated by the Egg-Cases of Chumæroid Fishes," *Biol. Bull.* vol. vii pp. 105-112.

of the progeny and, indirectly, of its far less individual capsule-forming capabilities—with the result that a succession of closely correlated stages in variation must have coincided in both distinct directions”

From the phylogenetic viewpoint similar conclusions are drawn by workers in very different departments. Thus Sir E. Ray Lankester is impelled to state that “the conclusion that man is a part of Nature is by no means equivalent to asserting that he has originated by ‘blind chance’, it is, in fact, a specific assertion that he is the predestined outcome of an orderly—and to a large extent perceptible—mechanism”¹ H. F. Osborn, in an Essay on Darwin and Palæontology,² maintains that the evidence from palæontology “replaces the law of chance by another law, namely, that as in the domain of inorganic nature, so in the domain of organic nature *fortuity is wanting*, and the fit originates in many hard parts of the body through laws which are in the main similar to growth—laws the modes of which we see and measure, the causes of which we do not and may never understand, but nevertheless laws and not fortuities or chance happenings” Finally, Dr A. Smith Woodward in a presidential address to the Geological Section of the British Association³ made this suggestive admission: “Amongst these general features which have been made clear by the latest systematic researches, I wish especially to emphasise the interest and significance of the persistent progress of life to a higher plane, which we observe during the successive geological periods. For I think palæontologists are now generally agreed that there is some principle underlying this progress much more fundamental than chance-variation or response to environment, however much these phenomena may have contributed to certain minor adaptations” Such statements, when considered in the light of the insufficiency of other factors to account for the facts, suggest recognition of what at any rate looks like directivity.

The essential element, then, in the individual and

¹ *The Kingdom of Man* p. 9

² *Fifty Years of Darwinism*, p. 225. Italics in original

³ *Brit. Assoc. Report for 1909*, p. 463

racial series alike is the prophetic hint, the co-operant travail, the concurrent conditions, the convergence seemingly towards an end. Even under the frankly utilitarian explanation offered in Natural Selection, the question inevitably arises in each case, Utility for what? Why does the crustacean cast its carapace? Adaptation, wonderful in itself so far as present conditions are concerned, becomes deeply significant when expressed, *e g*, in the reproductive parts of organisms. The question becomes peculiarly insistent in face of the fact of variation occurring in a process capable of using it for a progressive growth. It is only intellect in some form that prepares for the future, mechanism acts only in the present. We may realise that phenomena come under law, perhaps we may even find in the implications of the fact of law a partial explanation of the phenomena. But certainly we are not entitled to deny the presence of design simply because we see that phenomena come under law. How is a thing done? and, What does it mean? are two very different questions. We can say about everything. It is law, yet if there are final causes there must be efficient causes, and the latter imply purpose—purpose which is not an element in the causal series, but represents the particular combination of the elements. Now, in the case of every activity that we actually know to express purpose, we can likewise trace law and mechanism. Accordingly, when we find law and mechanism on a great scale with progressive results which look as if purpose were in them, the fact of the presence of law and mechanism cannot exclude the conception of purpose, in fact, the probability is all the other way.

That the slowness of the convergence may obscure the end, so that we may even fail to appreciate the possibility of an "increasing purpose," is not remarkable. We miss the end sometimes because our eyes are riveted on some single feature that does not harmonise with our preconceived ideas. As we wander through the woods in the after-coolness of a thunderstorm, we pause abruptly before an isolated record of its trail and ask ourselves, Why did the lightning destroy that little tree?

We limit our conception of the energy at work to that particular instance, forgetting that the power that designs a cell is not exhausted in the cell, and is making an infinite number of other cells. The one thing we are looking at is not the whole product of the Infinite Energy, it is acting elsewhere at the same time. And yet we are not wholly satisfied. Might it not all have been done some other way? How do we know that things could not have been done in, say, some shorter way? But time, at any rate, in itself, does nothing. It is not time that makes our hair grey. Change does not take time, it makes time. The only efficiency is the agency expressing itself in phenomena. Time assuredly does not derogate from purpose.

We may agree, then, that if the world process had been due to chance, we might have had other possibilities of development, yet we have but one way, and that so wonderful that at various points it seems to us as if it had been designed. To this it may be replied that the fact that the World Ground acts as if it had plans and purposes, does not prove that it really has them. But as Professor Borden Bowne has clearly brought out,¹ in reality all objective knowledge is ultimately based on an "as if." We do not know that the sedimentary rocks were deposited under water, but only that they look "as if" they had been. We know that our fellow-beings have minds only because they act "as if" they had them, *i.e.* because their actions indicate order and purpose. "In short, the argument for objective intelligence is the same whether for man, animals, or God,"² and it is equally good for all. The surmise that Nature mimics purpose is but a play upon our ignorance—a play, however, that does not deceive us when we come to deal with ourselves. The great mass of individuals are conscious of themselves as agents of purposive action in a universe that responds to their intercourse with it, and of which they are an integral part, and believe themselves to be rational simply because they are in continual relation to a rationally constituted and conducted cosmos. In this world, which is not a multiverse but a

¹ *Theism*, p. 110

² *Op cit* p. 112

universe, shot through and through with the same basal principles, erected throughout on the same broad foundation lines, we may be sure that what appears to us as purpose in the realms below that of humanity, if not the expression of the elements of these particular orders, is yet the expression of a Will, a Freewill operating behind and in them all

And these considerations touch the heart of our argument. For we realise, in the first place, that we have minds, and that we are a part, products of the universe, so that in some way mind is related to the universe. At a certain stage in the onward sweep of this vast process, mind draws into organic being, as a result, there is greater adaptation on the part of the mind-informed individual. But the process itself must be something greater than this which appears as an aspect of it, even if in that aspect it becomes conscious, so to speak, of itself. Further, that universe is a unity, and it is therefore improbable that that larger part of it which we do not see or know stands in any essential contradiction to that part which we do see and know. Man certainly is capable of directive action upon matter, yet he is not independent of it. Man, the growing point of progressive life, is conscious of directive control. Spirit has had from the beginning some constant and natural relation to matter. It is there and at work. It and matter may be merely two aspects of the same thing, but it is there, directing and controlling as we know it directs and controls in the case most completely known to us—the human personality. So far as we grasp the fact that we are a part of Nature—thus abolishing the convenient though false distinction between artificial and natural, inasmuch as all the works of man are natural works—so much the easier will it be for us to realise the possibility of spiritual and directive control in the world not merely of life, but in the realm of matter. Reduce everything, if it be possible, to the physico-chemical level. In association with these elements spirit has at a certain level appeared—the human spirit in particular, which in all its achievements is purposive. We are aware of purpose in ourselves. We are conscious

of being influenced by ideals that are borne in on us, in virtue of which we strive and sacrifice ourselves. Sometimes we feel ourselves as instruments in the hands of a power "not ourselves, that makes for righteousness." Righteousness, at any rate, is made and as we realise the full dramatic sweep of the evolutionary process from its beginnings to the ideals that dominate the minds that are noblest, it is not easy to say that all this has merely fallen out.

When we look back and see the stages by which the earth was better fitted to serve as the environment for life, when we become aware of the various phases in the evolution of life as characterised by higher and higher individuation, with continual increase of significance and apparent movement towards an end, when we ask ourselves why the surviving species, being the only ones that could survive under the very definite conditions of their survival, are on the whole higher species, we find it difficult to get away from the idea of a scheme of progress which is a whole, and in its continuity is purpose. And when, finally, we are aware of ourselves as individuals, the temporary culmination of the movement which we can foresee will yet endlessly progress, our bodies, and mayhap the earth itself, falling away as the now unnecessary scaffolding of a life that is spiritual, when we are aware of ourselves as minds comprehending the process and realising it as having this particular character, we are tempted to ask not merely, Was it worth while? For we can suggest that in the creation of human personalities, we may, not unreasonably, discern the temporary goal of the world's development, and so can speak of that development as purposive. On such a view, death is no more the end of the individual's life than the moment of birth was the commencement of it, both are mere changes of environment. The ideal of which we become aware is interpreted by us as a purpose higher and greater than ourselves, which is working in us, and has been working all through the stages that led up to man. In our human lives this supreme purpose becomes conscious for the first time to other than the Eternal Mind. They live

most highly who most wholly assist and are nearest to it in thought and activity—its most perfect instruments. Yet they are a part of Nature, there is no break, and it is contrary to all analogy to suppose that that same purpose has not been working through all the preceding stages. Man can consciously assist it, and so it works more rapidly to-day, but that it was not in the earlier stages is the more difficult thesis to establish, not to believe in its existence in these earlier stages leaves us with a break, a miracle of unbelief.

Further, this purpose—if it be such—can exist only in or for a mind, the Divine Mind, immanent and operative in Nature, feeling and working its way, as it were, to perfect self-expression and self-realisation. Now the spiritual interpretation of Nature is the recognition of an orderly and broadly progressive evolutionary process, and the patient researcher is never put to final intellectual confusion, as would be his experience were the Universe a chaos instead of a cosmos. On the contrary, every stage in the adaptation of the human mind to Ultimate Reality has brought with it a corresponding unmasking of that Reality, whereby the partial illusions of previous stages have been corrected.

We repeat, then, that in human activity,—in its history and society which are themselves a part, the outcome, of the cosmic process—we find a clue to the whole, since we cannot leave that out which seems to be the temporary culmination of the process in which it is so deeply rooted, for while of only a small part of our past do we make use at any moment when we *think*, it is as the result of the whole of it that we *are*. Human life, as lived on its noblest plane, is full of meaning—contains a meaning, not fully clear, indeed, but still the mainspring of most human endeavour. To conceive of the whole process as purposive is indeed to transfer to the whole the character of the part, but much of the difficulty in this seemingly illogical transference will disappear when we represent to ourselves what is involved in the magnitude and complexity of that whole—the association, *eg.*, of the living with elements in which life never was manifested or has

ceased to manifest itself, and which will therefore not so clearly or directly manifest purpose

Further, what we know to be true of the part—for it is impossible to eliminate the conceptions of intelligence and reason from human life—looks as if it were true of the whole, and the hypothesis works. For man is not merely a *z*, the end product of a series, *a, b, c, d*

He is not a mere end product in a linear series, but something that is interconnected on all sides with everything else in the universe, so that he is inexplicable apart from the whole, and the whole is incompletely interpreted without him. This universe, which does not merely contain, but actually produces and combines the material particles, in association with which human thought and feeling are alone known to us, must itself stand in some sort of kindred relation to thought and feeling¹. The part owes its specific character to the whole, which stands to it in a genetic relation: the whole is that in which all the intermediate stages are implicit in a perfect synthesis.

This is, however, a very different thing from maintaining that the whole significance of everything on this planet is summed up in its relationship to man. Yet there is no vagary in maintaining that such relationship is a real aspect of all meaning. To do so is not to insist that the Carboniferous came into existence solely and expressly to supply coal to mankind. Still, as a matter of fact, we do get coal therefrom, and it plays a complicated part in human life, and so is far from being unrelated to a reality which occupies so large a portion of the field of existence. Coal and its value enter into the meaning of the Carboniferous flora as an objectively valid fact, when the objectivity of a thing is taken, as it ought, to include every aspect of its significance—its social relations in this case as well. "The very possibility of extracting from a thing a value shows that the possibility was in it, and therefore that it is a veritable part of a universe which sums up all actual relationships"². And the more one learns about these relationships, the

¹ W. H. Mallock, *The Reconstruction of Belief*, p. 186

² A. K. Rogers, *The Religious Conception of the World*, p. 102

more one realises how great is the universe, how fathomless must have been the initial meaning that has unfolded into the outcome of to-day, which will in turn develop into a result commensurate with the travail of a universe.

The reality of the world is revealed in the whole, rather than in its parts. Some explanation is wanted of the interaction and interconnection—the co-operant toil. A cross-section of the world taken at any particular point or moment will never give a complete statement of reality, for it is a process, and involves duration. Assuredly the end is not behind us, therefore we need not look to beginnings. The ideal, the living spring that moves the whole, will not completely disclose itself even in the present, but to the trusting heart and wistful mind will growingly be revealed.

CHAPTER XII

EVOLUTION AND CREATION

DESPITE the progress of the last sixty years at once in Science and in Biblical interpretation, it is still difficult to avoid the instinctive association of the idea of creation with certain conceptions supposedly derived from the majestic utterances with which the Book of Genesis opens. Possibly no passage in the world's literature has been the arena of more intense wordy warfare. Even yet the din of controversy over these verses has not wholly subsided, but in the growing calm their undertone of a sure sense of God begins again to rise above the lesser insistences, that have hitherto seemed to mean more to their interpreters. The day is fast approaching when infinitely more arresting than the story of the controversy itself, will be the wonder how any misunderstanding ever arose at all.

In offering an interpretation, the modern critic begins by disarticulating two Creation Narratives, of which the first, comprising Gen 1-11 4^a, belongs to P, the Priestly Narrative, while the second, including the story of the Fall, and covering Gen 11 4^b-11 24, is referred to J, an older stratum, the date of which may be assigned probably to the ninth century B C. The Creation Narrative of P outlines a cosmogony which was the inheritance of all the Semitic peoples, set down in this instance about the time of the Babylonian captivity, say 500-450 B C., by a learned and pious Israelite, possibly a priest. And yet his version differs from all other versions of the same story as rendered by sacred writers of Israel's far-off kin, for he has been inspired by the divine Spirit directly, and indirectly through truths handed down and developed by a long line of prophets and teachers,

to assert in these verses, (1) a pure and sublime monotheism. The mould of the Babylonian cosmogony, polytheistic and mythological, is retained but purified, and deliberately used by him, even with some contempt for it,¹ to give external shape to his assertion that the One God was the sole Creator of the universe and of every constituent element in it, giving expression, as with the ease of speech, to His divine thought and purpose. (2) That this one eternal and omnipotent Creator had placed Himself in peculiar and close relations to man, not only constituting him the crown of creation, but forming him in His own image in expression of His desire for near and loving association with him. (3) Of this communion of man with God the sign and seal is the Sabbath, an institution whose strictly divine origin demands its observance as an essential factor in the development of the race.²

In the literary structure of the narrative, features like the parallelism of its clauses,³ the recurrent phrases, the sharp antitheses, the dramatic setting of the whole, and the forward movement to a consummation, all point to its poetic, idealistic character. The standpoint is that of a devout man meditating on the world as he sees it in relation to its ultimate origin and to himself, and expressing in gratitude of heart his overwhelming sense of its clear witness to God. The majestic simplicity of the passage is ill-adapted to the involved theologisings with which men have sought to embellish it. Thus the conception of "creation out of nothing" has been associated with a Hebrew word that conveys no suggestion of the idea, and is often used of the regular production of terrestrial forms of life.⁴ In fact, there is not a trace of such an idea in Scripture from beginning to end,

¹ Cf. A. Jeremias, *The Old Testament in the Light of the Ancient East*, p. 175.

² It ought to be mentioned, however, that in Gen. ii. 1-3 there is no specific mention of the Sabbath nor indeed any command concerning its observance. The simple statement is that God desisted from creative work on the seventh day, and that He blessed and hallowed it. The writer antedates in his schematic representation

³ Cf. R. G. Moulton, *The Literary Study of the Bible*, p. 71.

⁴ Ps. civ. 30, Isa. xlii. 1, Amos iv. 13.

it is a late mental importation¹ Even more tangentially, others have imagined the days to represent great æons of time But the conception of the Hebrew writer is surely that of a natural day bounded by dawn and darkness He puts the work of the Creator into the working week of any ordinary labourer At the end comes the Sabbath rest God worked and rested, so must man

² Creation, from the Spiritual point of view, is a unity of which man is the head The creation began, and progressed towards man, after him none other creature was created³ The Old Testament conceives the world as a moral constitution with God behind it The world is a human world, yet also a moral world—the means of intercourse between man and God It is the fact of the moral character of the universe that explains how the external world is dragged into man's relations with God, reflecting these relations according as they are peaceful or disturbed, and even falling into a state of dissolution in the day of man's judgment⁴ Man is king over Nature, but he is a constitutional monarch He is her best, put forward by herself to rule over her The relationship between man and Nature is no mere pre-established harmony he feels himself to be a bit of Nature simply because he is so The truth of his headship over Nature leaves indefinite scope for scientific research Science cannot show that he is different from what he is, she cannot obliterate his spiritual nature The basal interest of the first Creation Narrative lies in its theistic conception of things, its moral interpretation of facts It does not quarrel with the facts It simply asks, Under what point of view do you bring them?⁵ and it is very interested to answer that the ultimate causality is God The processes may be very long or catastrophically sudden, they may be very varied both in character and scope All such investigation and discussion may well be left

¹ Cf 2 Macc vii 23, and later, some of the Early Fathers

² The two following paragraphs are largely based on reminiscences of an unpublished lecture by the late Professor A. B. Davidson

³ Ps viii 5

⁴ Jer i 46, Isa xlii 10, Zeph i 15

to Science There will be no conflict until Science maintains that the whole process goes on without the divine causality

There can be no doubt that the Creation Narratives were capable of suggesting an idea of immediate creation to those who had no other conception of that process The idea of immediateness in relation to the divine operations, however, pervades all Scripture Scripture knows no Energy but God all phenomena are immediately due to Him This is the religious idea Science cannot rob men of the feeling that what happens to them, happens through God Even if the old Hebrews had known all that we know, had understood all the steps in the divine progressive march of events, yet they would have seen God in all of them They could not get away from the sense of the divine working hand, any more than they could remove themselves from the divine presence As one of them wrote

“ Whither can I go from Thy Spirit ?
Or whither flee from Thy countenance ?
If I ascend to heaven, Thou art there !
If I made my bed in Sheol, Thou art there !
If I should take the wings of the dawn
And alight in the uttermost parts of the sea,
Even there would Thy hand lead me,
And Thy right hand hold me
Should I say ‘ Darkness, cover me !
And at night be it light about me ! ’—
For Thine darkness is not dark
The night shines as the day,
And darkness is like the light ”¹

Now, to this vivid awareness of the universal immediateness of the divine presence, there corresponded a strong sense of the immediacy of the divine working

The adoption of such a standpoint with relation to these Creation Narratives gives relief from a number of embarrassing situations The necessity of admitting the incompatibility of the first narrative with the long established truths of science, or even with the second narrative, has as little claim on our regard as the inclination to applaud subtle demonstrations of the anticipation in the same record of the most recent physical

¹ Ps cxxxix 7-12 (Wellhausen's translation)

achievements. In scriptural revelation man has never been taught anything that he could learn for himself, and it is derogatory to the divine wisdom to think of it unfolding scientific detail to a pre-scientific age, or conveying fundamental religious truths by means of an unintelligible vehicle. Strictly, the pages of Genesis and the data of scientific text-books are incommensurate. It is as if one attempted to equate the symbolism of Watts' pictures with the chemistry or physics of his colour-box. The real marvel is, that now that we know a little of the method of creation, and have also learned the essential message and significance of these initial verses, the twin revelations of Science and of Scripture, so far from contradicting one another, prove to be complementary. Accordingly, we are left free to accept all the genuine results of scientific research that bear on man and his place in Nature, while we rejoice in the light shed in these verses upon those ultimate questionings which Science can never answer. The lantern itself may by some be considered faulty. It is, at any rate, of antique design. But, on the other hand, the more the lantern is battered, the more the glass is broken, and cracks and flaws in the framework opened up, the clearer and stronger shines out the light that lightens all the universe.

The Doctrine of Special Creation

The doctrine of Special Creation, till recently associated with these early narratives, derived much of its authority from the supposed fact of its acceptance through all the Christian ages, an acceptance that was also presumed to have been first seriously called in question as the result of Darwin's investigations. On the contrary, the doctrine has a very definite natural history, some of whose stages are well defined. One of these is foreshadowed in the distinct rejection of a literal interpretation of the Creation Narrative by St. Augustine (354-430 A.D.). In his mind there was a clear distinction between the definite creation of organisms and their gradual development under suitable

conditions out of invisible germs, latent in un¹formed matter. He deliberately rejected the idea of the days as solar periods of twenty-four hours. His was an evolutionary belief in potential rather than in special creation. "Accordingly," he says,¹ "that unformed matter which God made out of nothing was at the beginning called heaven and earth, and it was said, In the beginning God made the heaven and the earth, not because this state of things now was, but because it was able to be. Just as if considering the seed of a tree we may say that roots and trunk and branches and fruits and leaves are there, not because they are there now, but because they will be out of it so it was said, In the beginning God made the heaven and the earth, as if the seed of the heaven and the earth, since up to this point the matter of heaven and earth was in confusion, but because it was certain that from this the heaven and the earth would be, the matter was already called heaven and earth."

Nor was this view combated by St. Thomas Aquinas (1225-1274), the greatest of the Schoolmen. In fact, his positive contribution to the subject is simply an exposition of St. Augustine. "Nevertheless, with regard to the production of plants, Augustine holds a different view from others. For some expositors say that plants were actually produced each in its own species on this third day, as a superficial rendering of the letter (of Scripture) suggests. But Augustine, 5 *super Gen. ad litter.*, cap. 5 et 8, cap. 3, says that the earth is said to have produced herb and tree *causally* then, *i.e.* received the power to produce. This view he confirms by the authority of Scripture, for in Gen. 11 4 it is said: 'These are the generations of the heaven and the earth when they were created, in the day in which the Lord made heaven and earth, and every plant of the field before it was in the earth, and every herb of the field before it grew.' Therefore, before they appeared upon the earth they were made causally in the earth. However, this is also confirmed by reason, for in those first days God made the creature primarily or

¹ *De Genesi contra Manichæos*, Liber primus, Caput vii

causally, from which work He afterwards rested, yet nevertheless in His administration of things created, works to this day in the work of propagation. For to produce plants out of the earth belongs to the work of propagation. Accordingly on the third day plants were not produced in actuality, but only causally."¹

On the other hand, largely on the strength of an article by T. H. Huxley entitled *Mr Darwin's Critics*,² it becomes clear that with Francisco Suarez (1548-1617), the last great name amongst the Schoolmen, should be associated much of the ecclesiastical responsibility for the promulgation of the doctrine of Special Creation. He devoted a treatise to a consideration of the six days of Creation, in which he distinctly rejects the Augustinian principle of interpretation, affirms that the days referred to were ordinary days of twenty-four hours, and that the work of Creation took place in six such days. Huxley concludes in reference to Mivart's claim of Suarez as an evolutionist: "As regards the creation of animals and plants, therefore, it is clear that Suarez, so far from 'distinctly asserting derivative creating,' denies it as distinctly and positively as he can, that he is at much pains to refute St. Augustine's opinions, that he does not hesitate to regard the faint acquiescence of St. Thomas Aquinas in the views of his brother-saint as a kindly subterfuge on the part of Divus Thomas, and that he affirms his own view to be that which is supported by the authority of the Fathers of the Church."

The simple fact is that towards the close of the sixteenth century, under a pressure the complex nature of which has not yet been fully elucidated, a theological reaction set in against the wonderfully sound positions of some of the greatest of the Fathers, and from the date of the burning of Giordano Bruno till the middle of the nineteenth century, Special Creation became the orthodox teaching of the Church. Into this pressure

¹ St. Thomas Aquinas, *Summa Theol.*, Prima Pars Quæst. LXIX art. 2.

² *Collected Essays*, II p. 120, originally in *Contemporary Review* for November, 1871.

entered the Calvinist insistence on the "pure word of God" The doctrine of Special Creation is thus a product of "the spirit of the Puritan movement, with its insistence on literal interpretation and verbal inspiration,"¹ a spirit that received superlative expression in Milton's account of Creation in *Paradise Lost* The remarkable feature is that just about the same time, taxonomy was coming into existence as a science,² and men interested in the classification of plants and animals were exercised about the question of species and their fixity The stereotyping of the conception from the scientific point of view was accomplished in Linnæus' memorable definition "Species tot sunt, quot diversas formas ab initio produxit Infinitum Ens, quae formae, secundum generationis inditas leges produxere plures, at sibi semper similes" Yet he only knew and described some four thousand different kinds of animal, and they not unnaturally seemed to correspond to the "kinds" of which he read in Genesis No such interpretation of the Creation Narrative is possible for the individual who realises, that for every "kind" known to Linnæus more than two hundred are known to-day, and who further possesses and has understood the clear alternative view of Creation by evolution

Yet it should not be supposed that fixity of species and Special Creation were subscribed to by all men of science and all theologians within the period named "It is hardly credible to us," wrote Aubrey Moore,³ "that Lord Bacon, 'the father of modern Science' as he is called, though he was only a Schoolman touched with empiricism, believed not only that one species might pass into another, but that it was a matter of chance what the transmutation would be Sometimes the mediæval notion of vivification from putrefaction is appealed to, as where he explains the reason why oak boughs put into the earth send forth wild vines, 'which,

¹ Prof E B Poulton, *Essays on Evolution*, p 56

² John Ray (1627-1705), the first great British taxonomist, was a younger contemporary of John Milton

³ *Science and the Faith* (1889) p 174

if it be true (no doubt),’ he says,¹ ‘it is not the oak that turneth into a vine, but the oak bough, putrefying, qualieth the earth to put forth a vine of itself’ Sometimes he suggests a reason which implies a kind of law, as when he thinks that the stump of a beech tree when cut down will ‘put forth birch,’ because it is a ‘tree of a smaller kind which needeth less nourishment’ Elsewhere he suggests the experiment of polling a willow to see what it will turn into, he himself having seen one which had a bracken fern growing out of it¹ And he takes it as probable, though it is *inter magnaia naturæ*, that ‘whatever creature having life is generated without seed, that creature will change out of one species into another’ Bacon looks upon the seed as a restraining power, limiting a variation which, in spontaneous generations, is practically infinite, ‘for it is the seed, and the nature of it, which locketh and boundeth in the creature that it doth not expatiate’ Here the fact of transmutation is taken for granted, generation from putrefaction being sometimes called in as a *deus ex machinâ* to explain it But Bacon certainly had no idea that the existing species of plants and animals represent those originally created by God,” and his general standpoint was later shared by Buffon, Lamarck, Treviranus, St Hilaire, Goethe, and other early transmutationists

Likewise, in John Wesley’s work, *A Survey of the Wisdom of God in the Creation*,² there occur these striking passages “All is metamorphosis in the physical world forms are continually changing the quantity of matter alone is invariable the same substance passes successively into the three kingdoms the same composition becomes by turns a mineral, plant, insect, reptile, fish, bird, quadruped, man”³

“This immense system of co-existent and successive beings, is no less *one* in succession than in co-ordination, since the first link is connected with the last by the intermediate ones Present events may make way for the most distant ones

¹ *Nat Hist*, Cent VI 522, fol ed

² 3rd edition in 5 vols, 1775

³ *Op cit* vol iv p 109

"In the universe all is combination, affinity, connection. There is nothing but what is the immediate effect of somewhat preceding it, and determines the existence of something that should follow it.

"There are no sudden changes in nature, all is gradual, and elegantly varied. There is no being which has not either above or beneath it some that resemble it in certain characters, and differ from it in others.

"Amongst these characters which distinguish beings, we discover some that are more or less general. Whence we derive our distributions into classes, genera, and species. But there are always between two classes, and two like genera, *mean* productions, which seem not to belong more to one than to the other, but to connect them both.

"The polypus links the vegetable to the animal. The flying squirrel unites the birds to the quadruped. The ape bears affinity to the quadruped and the man.

"But if there is nothing cut off in nature, it is evident that the distributions we make are not hers. Those we form are purely nominal, relative to our necessities and the bounds of our knowledge. Those intelligences which are superior to us, discover perhaps more varieties between two individuals which we range under the same species, than we do between two individuals of distant genera.

"By what degrees does nature raise herself up to man? How will she rectify this head that is always inclined towards the earth? How change these paws into flexible arms? What method will she make use of to transform these crooked feet into supple and skilful hands? The ape is this rough draught of man, this rude sketch, an imperfect representation, which, nevertheless, bears a resemblance to him.

"Mankind have their gradations, as well as the other productions of our globe. There is a prodigious number of continued links between the most perfect man and the ape."¹

¹ *Op cit* vol iv pp 56, 60, 61, 86, 92. I am informed by the editor of the *Proceedings of the Wesley Historical Society* that the passages quoted in the text "are mainly a translation and adaptation

Although views of this general nature were also held by others within the Roman¹ and Protestant communities, their isolation as dissenters from the current narrower views was even more noticeable than in the ranks of Science. There is no doubt that the precise authoritative Linnæan conception, subscribed to likewise by Cuvier, the founder of comparative anatomy, and based supposedly on Scripture, by its very rigidity of definition served to obscure the vague conceptions of organic evolution adumbrated by some of the old Greek philosophers, naturalists, and even theological Fathers. It may be, as Dr Dixey remarks,² that the Linnæan conception of the reality and fixity of species as corresponding to the deeply felt need of "an accurate nomenclature of the forms of life" perhaps marks a necessary stage in the progress of scientific inquiry. It may be that a reaction from the rich, warm Oriental views about the living earth and its living products, with which the teaching of the Greek Fathers is suffused, was necessary in order that men might examine more closely, and so form more accurate opinions as to the character of these products. But it is certain that what is required to-day is again a measured swing back from our cold Occidental static view of things, tinged as it is with an aversion to Nature—a legacy from the Latin theology that was grafted on to the pagan conceptions of our wind-swept northern ancestors—to the palpitating Nature-loving thought of the Orient.

of Charles Bonnet's *Contemplation de la Nature* 1764-5" of which an English translation was published not long after. In 1787 Wesley published Bonnet's *Conjectures Concerning the Nature of Future Happiness*. This latter pamphlet emphasises in terms of gradual progressive advance the idea of continuity and scales of being characteristic of Bonnet. I doubt if Wesley translated them himself.

Wesley's eclecticism is illustrated in both cases. He was greatly attracted by Bonnet's idea of scales of being and continuity and it may be that his speculations in one of his sermons on a future state for animals was suggested by Bonnet's theory on that curious subject.

¹ Mivart gives the names of Father Pianciani of Rome, Cardinal Wiseman, and others (*Lessons from Nature*, pp 440, 442).

² *Church Quarterly Review* October 1902, art 11 p 28

Creation and Providence

How, then, shall we think of Creation? The alternative is between Creation by evolution, and Creation by intrusion and fabrication in separate acts. Each presents possibilities of design, except that on the former supposition the design will be on a grander and more comprehensive scale. Every man is a partial evolutionist. The difficulty for some is in realising that all the world processes are processes of growth, that all the varied forms of life of these and other days are inter-related and bound together by a common descent, provided we trace their pedigree sufficiently far back, that "God hath made of one every nation of men"¹ For such minds glimpses of divine activity are caught amidst the doings of the human race, but the witness is scant amongst the lower creation, while the realm of the inorganic is as Sheol, which cannot "praise the Lord"²

"Science," said Clerk Maxwell in a still famous article,³ "is incompetent to reason upon the creation of matter itself out of nothing. We have reached the utmost limit of our thinking faculties when we have admitted that, because matter cannot be eternal and self-existent, it must have been created." Our views of matter have been completely revolutionised since these words were written, and in the process it only seems to come out more clearly that there always has been a manifestation of God. "In the beginning, God." Science knows nothing of ultimate origins—she cannot dispute that sublime word. None the less a beginning is for her unthinkable. Her outlook to-day is upon a world that seems to vanish from the material point of view, but which is nevertheless an expression of Infinite Energy. The old terms remain, but their content is different, the old world is still there, but more than ever it is not in its inner being what it at first appears to be. Resolve the atom into its constituents, explain it in terms of particles of negative electricity (electrons)

¹ Acts xvii 26² Isa xxxviii 18³ Article "Atom," *Encyclopædia Britannica*, 9th ed (1875) vol iii p 49

revolving in an orderly manner around a densely packed nucleus composed of elements of positive electricity (protons)¹ and electrons, work out the problem of expressing these electric particles as peculiarities, bubbles or vortices in the ether, or what comes to the same thing, interpret both in terms of the single ultimate medium composing the material universe, and yet the wonder will not lessen. We are no nearer the beginning, no nearer understanding what Creation is. The final analysis of the physicist leaves us with an invisible, all-pervasive Infinite Energy and an invisible, impalpable vehicle of expression, it pushes out beyond the last boundary of the seen, "compelling us to believe, as we were told long ago, 'that what is seen hath not been made out of things which do appear,'"² but is the direct continuous offspring of an unseen universe and an indwelling yet transcendent Power"³ We are in the presence of the dematerialisation of matter, and perhaps even more significantly, of the materialisation of Energy⁴ The same sense of a Beyond confronts us in biology "We now perceive that that order (in the world of zygotes) rests on and is determined by another equally significant and equally in need of 'explanation' "⁵

Features in the evolutionary process presenting the characteristics of purposive intelligence have led us to the recognition of a directive factor. In other words, the Infinite Energy shows the characteristics of Thought in its working. Of pure thought we know nothing, all we know are its activities and forms of expression within the limitations of our present existence. These are very varied according to the character of the medium of expression⁶ They include a wide range of activity, from the instinctive act with its minimum of consciousness to the definite effects that are wrought in material, organic

¹ The proton is now identified with the charged hydrogen atom

² Heb xi 3

³ Sir W F Barrett, "Creative Thought" *The Quest* vol 1 No 4

⁴ L Rougier, *Philosophy and the New Physics*, p 148

⁵ W Bateson, "Evolutionary Faith and Modern Doubt," *Nature*, vol cix p 554

⁶ For detailed illustrative examples reference may be made to the suggestive article by Sir W F Barrett cited above

and inorganic, as the result of mental action. In every case, within the activity or behind its results is the energising Idea, ever transcending its medium of expression, the failure of their presentation is the perpetual plaint of poet and of painter. Yet that which is everywhere manifest is the continual tendency of thought to objectify and externalise itself: thought is essentially creative.

On such a view the universe will represent partially and tentatively the content of a conscious experience faintly analogous to our own. Nature, that is to say, represents something that is real and true for the divine experience, although it is not the whole truth, nor the whole reality. It is a partial phenomenal manifestation of the invisible Energy of the universe, like a visible cloud in a great encompassing atmosphere. This higher world order is the objective to the eternal, self-existent God, through which and in which His omnipotent will acts, and carries out His purposes.

Accordingly it is not helpful to think of Creation as an event at some definite point in time. To do so involves such a tremendous change in the life of Him whom we think of more worthily and fundamentally as unchangeable, meaning thereby, self-consistent in His character. It is difficult to conceive why just at one particular point in time God should give utterance and self-expression in Creation. We may, of course, fall back upon the fellowship of the Trinity as the *motif* of the pre-creational æons, we may imagine that we are preserving the divine freedom by positing Creation at some definite point in time. But neither conception seems to fit in with that dynamic aspect of divinity that is revealed in such a declaration as "My Father worketh hitherto, and I work"¹, while the conception of God as Love involves the idea of an eternal outgiving in Creation. "We cannot therefore say that there was a time when God had not yet made anything," concludes the evolutionary Augustine². "Not then for the first time did God begin to work when He made this visible world,

¹ John v. 17

² *De Genesi contra Manichæos*, Lib. prim. Cap. 111

but as, after its destruction, there will be another world, so also we believe that others existed before the present came into being,"¹—so had Origen expressed himself even earlier. Every day is a day of creation, every spring is a creative spring, God is eternally a Creator.

Nor should we think of Creation as involving the absolute separation of Creator and creature. Whilst the deficiencies of Pantheism will save us from asserting any identification of God with the world, yet must we bear in mind their close relationship. We may think of them perhaps as two elements in the one universe of Being, that which is relatively permanent and unchangeable in itself, and that which undergoes or is subject to change. Yet the latter has its cause in the former, which must be conceived of as Will and purposeful activity. This means that Creation is change, the new being the creature. The series of changes as a series may be eternal—probably is. It will always be truer to experience to think of that constant process of change that we call the flow or stream of events as without beginning or end, to think of the existence of the universe, bound so closely to God as it is, as eternal or infinite, and as such simply because of His will. The series of changes in itself as a series is eternal, but each element constitutive of the series is not in itself eternal, but has a beginning and an end in time. So regarded, all that Science knows of causes and effects, of the sequences and laws of Nature, will constitute her partial answer to the problem of Creation.

Thus to think of Creation as an endless process, so far as we know or can best judge of it, compels us to realise in God the indwelling, informing Principle, the immanent reason of the development of the world. In employing the term "divine immanence," emphasis is laid on the continuous activity, the informing and sustaining relationship of God to the universe. It is, however, a relationship, not an identity. God is in the universe, He is with it, but He is not the universe. The universe is in God and with God, but the universe is not God. Therein lies the vital difference between views

¹ Origen, *De Principiis*, trans. by F. Crombie, p. 255

pantheistic and panentheistic His universal presence in the world is creative and sustaining through the operation of His will, without the divine Reason was not anything made that hath been made Were He to withdraw, we could only imagine the shrivelling up of the universe, the vanishing of law and order—chaos, destruction, and dissolution Yet is it in the realm of spirit—the ordering of the spiritual world—that most clearly the divine immanence reveals itself

In these great topics analogy can aid us very little Continually we find ourselves but skirting the shores of a great continent—that world which we know—when we had started out to chart the ocean of God's Being It is characteristic, however, of our humanity to look into man's nature, and see what reflection it can give us of that which we know so greatly transcends it Thus it is in reflection upon self-consciousness and our persistent self-identity that we reach the idea of the transcendence of God in relation to the world, meaning thereby that God is not exhausted, so to speak, in those aspects of Himself in which He is revealed to us Such a thought forbids us ever to think of the universe as simply equivalent to God, and emphasises our thought of it as being the visible expression of an indwelling Divine Life which yet is something more than the sum of operations of natural forces He is immanent in Nature, but He also transcends her He is greater than all that we see or know by searching we cannot find out God unto perfection But in His transcendence we think of His self-existence, of His creatorhood, of His power to produce, sustain, order and love the universe Nor is there anything mutually exclusive in the two aspects of Immanence and Transcendence, for we may be sure that that creative Spirit which is Love will be desirous of remaining in close relationship with that which He has willed into being

Religious thought leads us to the conception of the World Ground, immanent and transcendent, as personal If it is rational and intelligent, it must also be conscious and personal Of course we cannot form a clear conception of such infinite unconditioned personality We

are certain that it is something richer in content than our personality. The divine activity, the divine nature can never be wholly understood by our finite minds, but we do not deceive ourselves when we live believing that the character of the World Ground has affinities with what is truest and best in our own activity. This is not to make man the measure of the universe, still less of God, but it is to realise that He is not something less than man. God is not less but more than a Person, or rather, personality proper is predicable only of God. Every objection to the conception of the Divine Personality is simply evidence of the limitations and incompleteness of human personality.

Further, as a result of these considerations, we may be helped in our understanding of the terms "natural" and "supernatural," the latter of which is both misleading and un-Scriptural. For one thing is certain, viz., that the universe admits of no dissection into parts that are natural, and parts that are supernatural, it is no image with natural feet and trunk of clay, and a head of supernatural precious metal. More truly conceived as physical and spiritual, the universe reveals itself as a whole, physical in its objective measurable aspects, spiritual in the manner of its continued and purposive upholding and energising by God. Nature is the orderly guise of the ultimate Spiritual Causality, and events are then "natural" in the mode of their occurrence, and "supernatural" in that they all alike rest on that creative and quickening Good Will in which all things literally consist. There is nothing from the Protozoa to man, from the pebble to the river, in which the "natural" and the "supernatural" do not appear in closest relationship, and the former is absolutely and at all times dependent on the latter, although the expression occurs in varying degrees according to the expressive power of the object.

Finally, we are also helped in our interpretation and understanding of Providence. Here in particular linger traces of that practical Deism with its conception of occasional intrusions, that is so damaging to the life of faith, and so contrary to experience as we know it. It

is common to talk not merely of Providence, but providences, and even "special providences." Yet any particular providence will, when examined, always take the form of a definite specific co-ordination of events such as will be found in any providence, and, in the case of the special providence, all that really happens is that the divine purpose and causality which are in all things have become more apparent to us. At other times our eyes are holden or become dim, and the purpose and causality equally present, equally determinative, are missed by us. For if our conception of the relation of the physical and spiritual is right, and if things are because of their significance, then there is purpose in everything, although not necessarily in the same degree. But when we realise that divine wisdom and power are at work in all things, when we can prove in our experience that God is able to mould and co-ordinate the conditions of His world into a system that executes His will for us and through us, so that things have a continuous significance, and even in their most seemingly physical aspects can work to our spiritual advantage, we shall cease to lay stress on "special providences."

Our human tendency at once to avow and disavow is seen in reports of selective human disasters, which sometimes conclude by a reference to those who were "providentially saved."¹ But was there no providence for those who found no way of escape? Belief in God and in His Providence must cover all the facts, and demands long-distance views. It demands time—perhaps Eternity, yet the patience of Nature is the patience of God. Just in the degree that freedom means anything, and man realises his power for evil or good, will the divine plans involve failure and defeat no less than victory and success, loss just as well as gain. But when we see that these things do work "an exceeding and eternal weight of glory," that in the moments of most signal seeming defeat are born convictions that ultimately prove invincible, that death's apparent victory consists but in the removal of the husk concealing the powers of an endless life—when, in short, we,

¹ Borden P. Bowne, *The Immanence of God*, p. 63

250 SPIRITUAL INTERPRETATION OF NATURE

realise that we are in God's world, even if we cannot comprehend in fulness the mystery of His ways, then does the course of Nature become in a new sense to us the revelation of His care, the symbol of His providence And this His providence is over all

CHAPTER XIII

MENTAL EVOLUTION

As the investigator gradually realises the cogency of the evolutionary conception, it becomes increasingly clear to him that there is no point at which he can desist in his application of it as a modal interpretation. Yet, when he reviews his distinguishing features as man, he may well be pardoned if he shrinks from the thought of submitting those which he has deemed unique, to the solvent influence of the new organon, on the other hand, he may rejoice in the vision of a successful corroboration in regions of more subtle influence. This difference of viewpoint is well brought out in the case of the co-discoverers of Natural Selection. "My object," said Darwin, "in this chapter is to show that there is no fundamental difference between man and the higher mammals in their mental faculties" ¹ A. R. Wallace, on the other hand, stated his belief that such a conclusion was "not supported by adequate evidence, and is directly opposed to many well-ascertained facts" ² Evidently we have reached a point where the difficulties are great, and we must proceed warily. Evolution is a jealous mistress, she will have all or nothing. Let us inquire into the reasonableness of her claim. If she is worthy, the surrender, though hard, will not be refused by the loyalist to truth, indeed, his only course is to obey.

Evidently the psychologist and the biologist approach the question from different ends of a chain, so to speak. The former is impressed with the uniqueness of self-

¹ *The Descent of Man*, p. 99. Darwin's treatment of Mental Evolution has hardly received adequate recognition.

² *Darwinism*, p. 461.

consciousness, the latter wonders at the sentiency of the simplest forms of life. The difficulty lies in getting each to appreciate the other's facts. Neither will dispute, however, that mind is in some way ordinarily connected with brain. What the relationship exactly is, constitutes a problem of fundamental difficulty. It is not any more easy to conceive how mind exists in association with a brain, than it is to think of it apart from a brain. The relation may be inscrutable, but we cannot insist that it is necessary. To this particular aspect we shall return later.

The biologist's contribution to the problem consists in showing that there has been an evolution of the organ of mind, and corresponding to this in some way, the comparative psychologist finds a certain grading of mental qualities. Yet the problem becomes quickly complicated even for the biologist. He will have traversed some considerable way on the upward gradient of life before he finds any structure which he can describe as an organ of mind, and, further, however carefully he examines the taxonomic scale, he will have great difficulty in pointing to any particular living form, and saying "There for the first time consciousness is present." Again, at every stage the interpretation is bound to be peculiarly precarious. Our knowledge of mind in our fellow-men is inferential, the only consciousness of which we are aware at first hand is our own. Particularly, therefore, have we to watch against reading into the actions of other creatures such an antecedent psychical sequence of events as we are familiar with, in the case of our own minds.

These difficulties meet us at the threshold of our study. We have learned to think of irritability as a fundamental characteristic of life, but at what precise stage such irritability, with its allied sensitivity, passes over into direct sensation, we cannot say. In the plant world we have expressions of this irritability in the geotropism of the young leaf, and the sensitivity to moisture in the root-hair. In the Protozoa, where the whole creature shows the capacity of response, we see clear expressions of this irritability in the different

tactisms—largely chemical and thermal—which involve so high a degree of determination of the organism by the environment. Loeb and others have indeed expressed all protozoan and other activities in terms of tactisms and tropisms, which form in their opinion the raw material out of which the higher instincts are developed. Touch alone, it is held, without the sensation of touch, is possibly sufficient for Ciliate life. The degree of irritability varies with mobility, yet it is felt to be unwarrantable to affirm accompanying sensation, particularly as many complex reactions go on in our bodies, *e.g.* digestion, without sensation. On the other hand, those who have given most attention to the matter find it exceedingly difficult to account for all protozoan activities in terms of physico-chemical attraction alone. If the power of conscious choice is taken as a criterion of mind, it is perhaps not possible to maintain this of the Protozoa, yet, on the other hand, it seems even more difficult to explain what the observer sees in terms of absolute determinism. The persistent refusal of the *Amoeba* to ingest a grain of silica, while yet it will engulf the silicious shell of the diatom, is something more than the refusal of oil and water to mix, or the rushing together of H and O to form water. The predatory Ciliata show considerable cleverness in the way they capture their prey. H. S. Jennings sums up several years of work on the behaviour of the lowest organisms in these words: "This work has shown that in these creatures the behaviour is not as a rule on the tropism plan—a set, forced method of reacting to each particular agent—but takes place in a much more flexible, less directly machine-like, way, by the method of trial and error. This method involves many of the fundamental qualities which we find in the behaviour of higher animals, yet with the simplest possible basis in ways of action, a great portion of the behaviour consisting often of but one or two definite movements, that are stereotyped when considered by themselves, but not stereotyped in their relation to the environment. This method leads upward, offering at every point opportunity for development, and showing even in the unicellular organisms what must be con-

sidered the beginnings of intelligence and of many other qualities found in higher animals. Tropic action doubtless occurs, but the main basis of behaviour is in these organisms the method of trial and error."¹ Confirmation of these results is given in further work along different lines by S O Mast,² who states specifically that "the light reactions of *Stentor coeruleus*, both free-swimming and fixed, cannot be explained by the application of the tropism theory," i.e. the organisms do not orientate in strict and immediate relation to the direction of light rays, but by means of a specific motor reaction which consists in turning towards a structurally defined side, and is repeated many times if necessary, until "the anterior end of the animal happens to become directed from the source of light."

Pursuing the inquiry along biological lines, and passing over the Sponges, which, while showing a sluggish neuroid sensitivity in many tissues, are yet "devoid of true nervous elements,"³ we come to forms like *Hydra*, or the sea-anemone, with a typical gastrula body-form, where the outer layer, in contact with the environment, develops sensitiveness to outward stimuli. From this outer layer or epiblast eventually, in the case of the higher animals, the central nervous system—even the brain—is developed. It is the primitive sensory organ, responsive to every kind of stimulus. The later differentiation consists in the development of special organs to respond more effectively to different kinds of stimuli. Further, we may assume, as a result of our ideas of the unity of the organism, that effects in the epiblast will cause secondary effects in the hypoblast, even before the development of a nervous system. In the Coelenterate group, however, there is as yet no differentiation into sensory and motor nerves. The nervous system takes rather the form of a "nerve-net" with nerve cells and branching fibres, "some of which can be traced

¹ *Contributions to the Study of the Behaviour of Lower Organisms*, p. 252

² "Light Reactions in Lower Organisms," *Journal of Experimental Zoology*, vol. III No. 3, p. 392

³ G H Parker, *The Elementary Nervous System*, p. 49

in among the epithelial cells and others among the muscle fibres" ¹ By means of this primitive type of nervous organisation, the whole musculature of a jelly-fish or sea-anemone can be brought into activity by stimulation at any point on the surface, and a considerable degree of autonomy of movement can be experimentally demonstrated in detached fragments of this neuromuscular structure yet in default of a single nervous organ, the nervous activities of these creatures are uncentralised, and there is no possibility of a *common* consciousness Upon the differential sensitivity of the Protozoa there is a certain advance, but if the explanation as given in terms of tropisms fails in completeness in their case, it does so even more with the jelly-fish where sense-organs of a kind are developed, even if the degree of sentiency cannot approach that which we know as consciousness

The next stage that we may consider is that which is found in the organic lumber-room inscribed "Worms" By this time there has developed in the two-layered gastrula a third layer, the mesoblast, which in the higher forms gives rise to the musculature, a system always found in close connection with the nervous system ² Definite nerve cells are now introduced between the sensory and the motor fibres, where the impulse transmitted from the surface is transformed into an impulse communicated to the motor fibre, and so to the muscle Specific ganglionic groups of these nerve cells form the incipient brain With growing complexity of the nervous system, the nerve currents set up by stimulation of the sense organs give rise in the ganglia to sensations—delicate, discriminating stimuli that release indirectly specific stores of energy, collected in various masses of contractile cells Nervous impulses received through the medium of the sense organs are in this way transmitted to the muscles

As we pass around the different groups in this vast assembly, and indeed ascend farther, considering particu-

¹ G. H. Parker, *op cit* p 105

² From the mesoblast are also developed the skeletal tissues, blood-vessels and reproductive organs

larly Crustacea and Mollusca, we note definite increase in the size and number of the ganglionic masses, some of which serve as brain, together with growing complexity of the connective nervous elements and sense organs. A very wide range of intensive study of starfish, earthworms, lobsters, and molluscs¹ has shown the necessity for giving up the older interpretations of invertebrate behaviour in terms of unconscious automatism. A "summation of stimuli" is noticeable, resulting in a response on the part of the animal, often different in degree—it may even be in kind—from the reaction that has hitherto normally followed a single stimulus. Thus the temporarily retained impressions—the per-

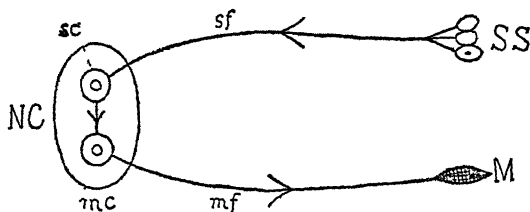


FIG. 10.—Diagram showing essential parts of an apparatus of exchange between the external world and consciousness

NC nerve centre, *sc* sensory cell, *sf* sensory fibre, SS sensory surface, *mc* motor cell, *mf* motor fibre, M muscle. Arrow-heads show direction of transmission. (After Leconte.)

sistent effects—of the earlier stimulus may have an inhibitive or modifying effect on the subsequent reactions of the creature. This primitive type of memory is apparently in evidence from the Protozoa upwards, although it becomes more marked with the development of true nerve cells. We find many cases of successively different reactions to stimuli of the "trial and error" type, but we cannot think of them as deliberately put into practice, in default of an organ for such conscious deliberation. Consciousness literally means the act of

¹ For a resume, cf S J Holmes, *The Evolution of Animal Intelligence*, also J B Watson, *Animal Behaviour*, W M'Dougall, *An Outline of Psychology*, and J Arthur Thomson, *The System of Animate Nature* (chaps vi and xvi.)

"knowing things together," and in these lower forms such awareness of stimuli, past and present, as is involved in this earliest form of memory, can only be of the most diffuse and dim character. But what is noticeable above the Protozoa is, in Jenning's words, that "stimulation causes varied movements which do not all lead toward the condition finally attained, and that those movements which do lead toward this final condition (the 'optimum') are followed up more decidedly than the others. The behaviour may perhaps be most accurately characterised as 'selection from among the conditions produced by varied movements'."¹

When we pass up to the Vertebrate Kingdom, we find in the most highly developed members of its lowest class a brain whose principal parts correspond, in a general way, to the parts of that organ in the most highly developed members of that great division of the organic world. The genetic connection between invertebrate and vertebrate, whether through worm or ascidian, though still obscure, is unassailable, and once the vertebrate brain has been definitely established, the progressive development is marked and unmistakable. Of the segmented nervous system of these humbler days, even the most highly developed vertebrate form still shows reminiscences, *eg* in the spinal cord. Such a forward-moving ancestor would find it advantageous to have its sensory organs in the anterior region of the body, a situation retained throughout, though somewhat disguised by the human upright attitude. At the same time, the task of comparing the brains of individuals of the different mammalian orders is one of peculiar difficulty, and has led to statements which credit Elephantidæ and some Cetacea with brains more highly convoluted than those of the Primates.

In the case of fishes, amphibians and reptiles, upon whose mental life, however, not very much work has been done as yet, the faculty of "associative memory"—the capacity for making new linkages—has also been demonstrated, but the degree of consciousness involved

¹ "Modifiability in Behaviour," *Journal of Experimental Zoology*, vol. III No. 3, p. 452

is still without any strict criterion. Granted that it is experimentally proven that the fish can learn by experience, and that it can modify its conduct in face of a new situation, yet the question always remains whether what has happened is the result of a low-grade conscious acquisition of a dim idea or the unconscious selection of an impulse—whether it does not unconsciously feel its way, rather than consciously think its way, into the successful attitude or activity. Associations are formed in the brain, it may be held, in virtue of which instinctive impulses are modified, but as yet these associations are unilluminated by active consciousness. Memory there is, but of that unconscious character that we have already seen associated with Semon's views on heredity.

At the level of the class Aves, we have reached a brain whose comparableness to the human brain is much more marked than at any lower stage, particularly in the development of the cortex, whose regional study has so greatly added to the understanding of the localization of definite functions. With such an organ it would be idle to deny the presence of consciousness, even if we should not expect that it was of the same degree or timbre as in the human subject. The gradual differentiation of association-areas from the sensory-motor areas, the successive development of posterior, median, and anterior areas of the cortex in strict association with progressively higher features of psychical life, may be traced in avian and mammalian brains with considerable exactitude. The bird can adapt itself in some considerable degree to new situations, but the adaptation is probably due to the selection of one of several associations of sensory impression and impulse—that one which has a pleasing issue. The initial responses under the new condition are as yet, however, really neither purposive nor intelligent, but still on the method of "trial and error." At the same time the growth of association-area means an increase of plasticity—escape from a single inexorable response to stimuli. Yet as the human being makes unconscious associations, we cannot definitely state what degree of consciousness illumines the new mental associations of the bird.

The closer degree of correspondence between the lower mammalian and human brains intensifies the conclusions tentatively advanced in connection with the avian brain. Association of impressions with impulses is clearly demonstrated, together with that externally determined selection of one particular impulse which proved beneficial. On the grounds of comparative anatomy—slender enough in this particular connection—a definite degree of related consciousness of these associations can hardly now be doubted. Comparative experimental psychology seems to indicate a gradual enlarging of the area of association, a progressive liberation of the elements associated, the dawning possibility of abstraction. The growth of reasoning may be expressed by the increasing remoteness and comprehensiveness of the elements associated, the enlarged repertory of recorded impressions out of which response is made to the exciting stimulus, we may also naturally expect to find greater rapidity in association. "Learning" consists in the elimination of useless responses, and the better recollection and application of useful ones, through continual effort along the line of "trial and error." In the anthropoid apes, the progress in these particular directions increases with continued approximation in structure to the human brain, whose lowest types may be placed in a not unnatural comparative relationship with them. Especially with finer discrimination in touch, and the progressive liberation of the fore-limbs from purely locomotor to prehensile and tactile functions, do we find a correlation in cerebral advance that begins with lemuroid forms, and is continued through the Primates group to man. The close regional connection of the higher "association-centres" with the motor-areas concerned in the movements of the hand and arm, and even of facial expression, suggests possibilities of mutual influence and reaction.

At this point the question becomes supremely important from the psychological side. With the increasing complexity of the organ of mind the psychologist has correlated an advance in mental power, yet in this particular phase where conceptual thought, and, later,

self-consciousness emerge, it is sometimes maintained that the degrees of physical difference bear no relation to the mental differences in kind that are ultimately established. Discussion of this point has, however, been hitherto hindered by static conceptions of consciousness, and by hard-and-fast definitions of the typical human and animal mind that correspond to nothing in reality. Just as some of the older naturalists believed in isolated species, refusing to recognise intermediate links, so to-day there remains in some quarters a certain hesitation to admit the graded expressions of the human mind as they may be found in various tribes. More remarkable even than the gradations in mental calibre amongst the higher mammals, is the wide range of mentality furnished by the existing races of mankind. We can no longer sharply contrast the human mind with that of the lower animal, thinking of the former as one specific type. Between the Berg Damara of South Africa and the European philosopher we have an enormous variety of type, and differences physical and mental comparable to those between the American monkey and the anthropoid ape. As we strive to represent to ourselves not merely the range and degree of human mental evolution, but also the range of animal mental evolution, we shall not be so disposed to emphasise "breaks," as to find the missing pieces that will make the puzzle picture complete.

For example, the distinction so apparently broad-based as that between abstract and concrete ideas is shaded out when we realise that some of the higher mammals have generalised ideas of certain objects, the dog has a concrete generalised idea of man apart from the particular concrete image of its master—the beginnings, that is, of abstract ideas. On the other hand, a race like the recently extinct Tasmanians had no word or phrase in their language that represented an abstract idea, and probably the abstract idea itself was conceivably attained by the continual superposition of similar concrete images, till, after the fashion of the composite photograph, the detail and particularisation vanished, and a vague community and essence of char-

acteristic were left Without speech, where art or sculpture are unknown, thought is not expressed, and, unexpressed, is probably rightly regarded as only faintly present The actual details in the not unimaginable development of self-consciousness in direct continuity with preceding stages, are irreproducible simply because we do not have, and never can have, any direct record of the earliest stages in the evolution of language The Berg Damara, neighbours of the Herero and Namaqua, are said to have lost their own speech, and now speak a Hottentot patois The real language of the bushman, rich in the characteristic clicks, some of which passed over into the Hottentot dialects, is probably irrecoverable Several modern tribes are unable to count beyond three or four In short, abstract and concrete ideas are not so absolutely unrelated to one another as the usual definitions imply We can even arrange a gradational series amongst modern types of higher mammal and lower savage—a series that assuredly has no genetic value, but which would represent closely graded stages of mental advance Far down below that scale, linkages of mental impressions first occur, speedily forgotten and drawn within narrow limits Progress consists in the retention of impresses, the enlargement of the field of association, the disengaging and development of that individuality that is not subject to the unconsidered utilitarian determination of action alone Man shares the capacity in common with many lower forms of having linkages arise in his mind between “situations or sense impressions and acts”, only, the ability to learn by selection of impulses—a power of freedom that emerges very slowly and is still evolving—is very much greater in his case than in theirs, and this ability is further obscured by his peculiar faculty “of thinking about things and rationally directing action in accord with thought”¹ We may not merely compare the perceptual abilities of man and the lower animals, and the possibilities of progress through “trial and error” and associations, the selection meantime being more passive than active on the part of the organism even if accompanied by

¹ *Animal Intelligence*, by E. L. Thorndike, p. 285

pleasure and profit, but we can actually trace the development of these abilities into that conceptual stage characteristic of man in which the selection is active, and determined more by himself than by the environment, for the power of profiting by experience has reached a maximum. Internal stimuli have now in great measure taken the place of those that were external, and often by transformation of the latter into the former within the mind.

To have traced progressive stages in the evolution of the organ of mind is not, however, necessarily to have proved the evolution of mind. Yet in the light of the historical argument, within the records of the human race alone, the probability of such an evolution almost amounts to certainty. In an antiquity, to which every year of recent study and discovery seems to have added a thousand, we can demonstrate along particular lines a progressive advance in cranial capacity, to which there must have corresponded a definite mental evolution, which is repeated in the individual life-history. In the prenatal stages the human brain passes through phases broadly comparable to the brain of the fish, of the reptile, of the marsupial, and of the young anthropoid, till we are startled into considering why it is that this last stage so comparatively slowly passes into the typically human form. Later, the actual passage is made through stages dominated by differential sensitivity, tropism, reflex or instinctive action, consciousness—for a period the child speaks of itself in the third person—and self-consciousness, there at least the terms do have a certain genetic connection, although all remain—are, as it were, carried forward—and go to the make-up of intelligence. Till the end of the first year, the intellect of the infant is largely of the animal type, the sole apparent difference being in the quantity and quality of the associations. Reasoning and ideational life have not yet arisen. Possibly the evolution follows the direction indicated by Thorndike, of passing from the animal characteristic of feeling things in gross, to the characteristic of human thought which “breaks up gross total situations into feelings of particular

facts" ¹ But to maintain that there is no solution in the facts of the ontogenetic history, and to insist on the uniqueness of the human series because it starts with a fertilised egg-cell that has in it all the potentialities of the later development, is to forget that no succeeding stage could ever be reached without some transaction with the environment, and that even that initial stage is not strictly such, as the germ cell in either case is linked with a whole antecedent heritage

So far we have outlined stages in a possible development of the organ of consciousness and of intelligence in particular, but no real understanding of the question is possible without a fuller reference to those peculiar activities grouped under the name of instinct Especially in the case of insects have they reached a remarkable stage of development In many cases instincts are peculiarly complicated, and the solution of the riddle of their origin has not made any recent great advance Geology reconstructs for us periods when as yet there was no winter (*e g* prior to the Late Carboniferous), and we may well suppose that some of the extreme racial instincts, *e g* of insects, were evolved in reaction with the changed conditions that a lowered temperature involved ² The development of the seasons with their contrasted temperatures entailed an acceleration of phases of the life-history—perhaps of the whole of it in the case of some insects—induced migration, additional protection for eggs, and other instinctive actions During such profound changes, the modifiability and adaptability that are characteristic of all living matter, would be peculiarly liable to be moulded by the environmental pressure into those more or less rigid associations of sensation and reaction that are known as instincts Physically we must assume the connection of instinct with the nervous system, and it has always been a plausible supposition that instinctive actions are no more accompanied by consciousness than higher reflexes in the human individual, or those habits of unconscious memory or inference with which human psychology is

¹ Thorndike, *op cit* p 289

² P Hachet-Souplet, *La Genèse des Instincts*, p 320

acquainted The analogy between the different castes of an ant community and the tissues of the human body is certainly closer than any that could be established between the powers of the ant and human brains Ordinarily, instinct is supposed to be independent of intelligence, yet purposive, unaffected by experience, involving the activity of the whole animal, and adapted to the survival of the species Recent research shows that no such hard-and-fast definition is tenable No instinct is perfect, and modifications and new departures are not unknown That these departures have not been more definitely recognised is probably due to the scant study that has been given to individual insects, and the likelihood that only very obvious deviations of great magnitude have been noted we should probably see countless modifications on a slighter scale were our vision and observation keen enough This loosening of the rigidity of definition does not, however, make it much easier to detect the exact relation of instinct to intelligence Certainly, the most extreme forms apart, as we ascend the animal scale, intelligence seems to replace instinct In man at any rate instinctive action is not the outstanding feature, he is *par excellence* the educable animal A common view of the relation between instinct and intelligence has found in the former a fixation and automatic performance, in response to a definite stimulus, of an act originally carried out with a measure of intelligence It is indeed tempting to suppose that in the case of man reflexes and instincts represent successful unconscious perfect performances of activities, that, in their original moulding, were the subject of conscious and laborious effort, but which once perfected, leave consciousness free for higher endeavour So far as certain secondary instincts and habits are concerned, this is no doubt what happens, yet as an interpretation of insect instinct, it must fail, proving too much, for it implies a degree of intelligence which could hardly have stopped even with a perfectly developed instinct, but must have reached out to some higher conquest And even if human reflexes are perfect, man's primary instincts certainly are not indeed his most character-

istic instinctive impulses require definite guidance and development, and the same is true of all creatures. Again, many instincts are so complex, and involve adjustments of such various kinds, that it is not easy to see how they could have sprung into being, complete and all of a piece. The argument against their mutational origin therefore seems equally valid against their origin as perfected instincts. The real difficulty in supposing that instincts are directly due to intelligence is the fact that most of them have reference to generations yet unborn, of which the individual insect has no knowledge. It is not clear how such benefits which affect the race and not the individual could have originated in individual acquirements. The problem has been complicated by the tendency to dwell on the instinctive activities of alert insects, instead of realising that the solution must cover the no less instinctive though laboured activity of the mollusc as shown, for example, in building its shell. Such a consideration immediately rules out the idea of instinct as lapsed or perfected intelligence.

Of the more recent contributions to this vexed problem, none has created wider interest than the solution offered by Bergson in his *L'Évolution Créatrice*. "The cardinal error," he says, "which, from Aristotle onwards, has vitiated most of the philosophies of nature, is to see in vegetative, instinctive, and rational life, three successive degrees of the development of one and the same tendency, whereas they are three divergent directions of an activity that has split up as it grew."¹ His analysis of the two faculties or modes of acting on the material world open to life, the one direct, "the faculty of using and even of constructing organised instruments,"² implying knowledge of things and concrete situations,³ intension of knowledge abintrally acquired, the other indirect, "the faculty of making and using unorganised instruments," implying knowledge of a form (relations), extension of knowledge abextrally acquired, is now familiar, with its conclusion of the inevitable failure of the one mode as a means of inter-

¹ *Creative Evolution* (Eng trans), p 142

² *Op cit* p 147

³ *Op cit* p 157

preting the other "Instinct is sympathy It is to the very inwardness of life that *intuition* leads us—by intuition I mean instinct that has become disinterested, self-conscious, capable of reflecting upon its object and of enlarging it indefinitely"¹ Yet the Bergsonian conception of a supra-consciousness combining originally more than instinct, intuition, and intelligence, appearing we know not where and gradually splitting into characteristic forms like instinct and intelligence in its endeavours towards self-realisation, is difficult of application to the data of organic life As a matter of fact, no sharp, absolute distinction can be drawn between instinct and intelligence, and in the arena of modification, disentanglement and correlation of instinctive impulses, intelligence gradually takes its rise

The *ensemble* of facts, accordingly, seems to indicate that the characteristic consciousness which we associate with man has evolved like any other character, and that as in the Protozoa we find in rudimentary form many cell characters of the higher creatures, *e.g.* contractility, digestion, assimilation, respiration—even if the terms do not cover strictly comparable activities—so also with the primitive adaptability and modifiability of Life's first offspring was associated something akin to a dim or diffuse consciousness

How may we suppose that this dim consciousness first arose in the racial history? Of the requisites of life none is more fundamental than food Whereas the crystal grows by adding like particles to itself, the organism grows by taking in unlike particles The exertion of assimilating the unlike must have involved difficulty We can hardly think of it as an inherent absolutely automatic power, even when conceived in terms of tactisms The living creature lays hold on the food, that implies effort and energy Effort is at the basis of all consciousness, its concomitant creative condition, and if consciousness thus results from effort, there must be a diffuse consciousness co-extensive with life If the cell had got food without labour,

¹ *Op cit* p 186

there would have been no effort on its part, and so no development of consciousness. Further, once that faculty was in any measure developed, any tendency towards sessility and corresponding reduction of effort would have had the effect of causing growth to express itself largely in the development of protective structures, for the animal and the plant that could not avoid peril by moving out of the locality of danger had to protect itself, and sensitivity, thus shielded, failed to advance.

But further, in these simpler organisms, psychical life must have been wholly instinctive in character, sensation and reaction being welded under the direct determining pressure of the environment into specific activities. Later, a stage came, not exactly definable, when within that sphere of instinct the original diffuse consciousness began to focalise and condense into consciousness as we know it, expressing itself as intelligence. Already low down in the scale of life, as we have seen, we become aware, in nascent form, of the distinctive feature of consciousness as we behold it in man—namely, its timeless ability to disengage and recombine impressions from sensations received at different times, for the present good of the organism. Something interpolates itself between the stimulus and the immediate reaction historically impressed upon the organism by the environment (reflex). The interloper selects amongst past and present impressions and to that extent modifies reaction. Herein lies the possibility of education. The bionomic value of such a power is at once evident. This with its growing capacities of realisation, assertive selection and rearrangement of inferences, and penetration into subtler aspects of the environment, is what is known as consciousness. By means of sensation it becomes symbolically aware of aspects of the environment, for the subjective qualitative sensations of colour are transmuted by it out of differing quantitative ethereal vibrations.

On the other hand, in insects, for example, their low-grade consciousness had less resource, through a generally more limited set of sense organs they had not such wide possibilities of interaction with the en-

vironment, which therefore moulded their impulsive activities in well-marked instincts. The apparent perfection and definition arise from the great age of the insects phylogenetically, associated with their extremely short ontogenetic history. The latter demanded, and the former has produced, a noticeable limitation, and exactness of life activity. Man, by contrast, is phylogenetically of yesterday compared with the insect. Consequently there has been little grooming or definite moulding of his instinctive impulses, and, further, this function of environment is increasingly taken over by the highly developed consciousness accompanying them, which is able to turn the edge of Natural Selection and control the instincts in large measure in accordance with other aspects of the environment. In virtue of this actively selective power of consciousness, this plasticity in response to environmental stimuli, this capacity for control of instinctive impulse, man shows himself supreme. Will is simply the assertion of an individuality which refuses to assent to the forced determination of the environment without consideration—which may dissent, but can also consent. Free will and consciousness alike are progressively developing faculties. In these activities man is peculiarly aided by his innate powers of memory—the capacity to make mental acquisitions, and revive and dislocate the time-order of conscious experience. The experience of the lower creatures is in comparison with his a somnambulistic series of disconnected moments, a continual consciousness of the present, in which only scantily are experiences greeted as familiar or unfamiliar.

We thus conceive of a diffuse consciousness accompanying the instinctive impulses that express the life of humbler forms, which was yet unable to mould them, this function being performed by the environment. In fact their instincts are a partial reflection of the mind of the environment in its ultimate sense. But as life progresses and consciousness develops, the latter interacts with various aspects of the environment in the control and moulding of the instinctive impulses, which are still there and have also developed, though

not to the same extent. Consciousness, however, is basal and primary, it is even not impossible that activities which appear completely reflex and instinctive now were more directly accompanied (though not produced) by consciousness at an earlier phylogenetic stage. "Certain facts in the comparative physiology of the vertebrate nervous system tend to show that in the lower forms (amphibia) a certain degree of consciousness presides over the functions of the spinal cord, which in mammals is devoted to reflex actions" ¹

On the views that have been enunciated in the preceding pages it would appear that we are left with Consciousness and Infinite Energy as two ultimates we may even venture to think of the former as the informing spirit of the latter. What then is the relation of mind to matter? The latter under the electronic theory is finally interpretable in terms of energy—atomic charges of electricity—so that the difficulty does not lie there. Rather is it in the relation of the individual consciousness to its "brain." All assumptions of a causal, *i.e.* productive relationship, are, however, ruled out by the simple consideration that if sense and feeling are indirectly allied with, or generated by, the inorganic, *e.g.* by the grey matter of the cortex as on the materialistic hypothesis, then quantitative relations must necessarily ensue. Double the quantity of grey matter will involve double the quantity of consciousness. Yet this is precisely what is shown not to be the case. For the brain, like many of the other organs, is a paired instrument consisting of two cerebral hemispheres, and while in the control of voluntary muscular movements and in the reception of bodily sensations, both hemispheres are employed, yet for all the ordinary and distinctive functions of mental life—reasoning, recognising, remembering, speaking—they are wholly independent of one another, and one alone is used. Neither hemisphere, as it were, knows anything at birth. The self employing them has to learn everything, and in learning slowly modifies the organ. Yet

¹ "The Problem of Consciousness in its Biological Aspects," C. S. Minot, *Science* N. S. vol. xvi No. 392

in all this it employs only one of the two hemispheres, usually the left, as associated with the right hand stretched out in the first mute inquiries of childhood ¹

Accordingly it is evident that brain matter in itself does not originate speech or thought, since both hemispheres would have on all analogy contained such centres. As a matter of fact either hemisphere can function in this way, but only one is employed. Mental capacity is not increased by the double brain any more than the faculty of sight is doubled by the paired eyes. The self employs one of the hemispheres in the development of thought and speech, the brain, that is to say, stands in no directly productive relation to mind.

Of such an ultimate in consciousness viewed as the informing spirit of energy, we may conceive the progressive manifestation through instruments of increasing organisation and complexity, each better adapted for partial revelation and expression, till finally in man is produced an individuality that is able to come into direct relationship with the Ultimate in its most personal aspect. What the nature of the interaction between spirit and matter is, we do not fully comprehend. theories of parallelism are as little helpful as the old idea of production and secretion. That which was in the beginning was Self-conscious Spirit. Its manifestations may change with the processes of the suns, but those that develop into likeness with it share in its eternal glory.

¹ With left-handed individuals the speech area is found in the right hemisphere. See W. H. Thomson *Brain and Personality*, where the whole question is fully discussed.

CHAPTER XIV

EVOLUTION AND MORALITY

At no point in the discussion of Evolution is it more important to remember with Henry Drummond that to give an account of a thing is not to account for it,¹ than in considering the relation of evolution to morality. The subject is closely related to the evolution of mind. We have noted a broad difference of degree between the mental life of man and those forms that are lower in the animal scale. Whereas, in the latter we see a life that is largely tactic and automatic, a consciousness that is mainly perceptive and impulsive, a responsiveness that is singular or instinctive, in man we find a growing freedom and increased selective possibility of response, while the conceptual character of his mind enables him not merely to interrogate and anticipate the environment, but also to put himself under the inspiration of ideals or ends. In such union with the environment he works its work, and in a sense selects himself for survival. In a peculiar way also the evolution of morality is almost a function of the evolution of society. Morality has no significance apart from the relation of an individual to some other individual, human or divine.

As in much else, we find that Darwin made the first attempt to treat of the origin of the moral nature in accordance with evolutionary principles.² For him the moral sense is an instinct similar in origin and character to other instincts. In order to be morally right, any line of action must result in some advantage, in which case the adoption of such line of action would be fostered

¹ *The Ascent of Man*, p. 6

² *The Descent of Man*, chapters iv and v

by Natural Selection. So far as illustration is chiefly offered by Darwin, the advantages are to other members of the same community, *i.e.* the moral nature is traced to the social instincts of certain gregarious animal forms and of savages, which in turn are probably a development of the parental or filial instincts. In some cases the illustration bears more directly on the individual life. Thus the bird that finds its food supply diminish under the severity of a northern winter can find salvation in migration. However this instinct arose, it obviously is of individual and racial importance. In obedience, therefore, to the demands of the environment it has to migrate. But if the bird could incipiently realise its relationship to present and future conditions, it would incipiently realise that it "ought" to migrate. Already even at this stage a struggle may be noticed between conflicting instincts, as when, "late in the autumn, swallows, house-martins, and swifts frequently desert their tender young, leaving them to perish miserably in their nests"¹. In the sequel, those individuals will be preserved under Natural Selection whose most assertive instincts prove to be the best adapted to their good. In the case of man, intelligence enables him to understand his social instincts inherited from earlier stages, and the realisation of the opinion of his fellows will begin to act as a factor in his surrender to one or other of competing instincts, indeed, such a consideration may ultimately come to be of more importance than the pain or pleasure associated with the gratification of the instinct.

As civilisation advances, and the smaller tribal companies of earlier periods united in the larger social communities of later days, the individual's destiny becomes more firmly bound up with that of the larger whole, even than it was in the days of the smaller collective unit. The growing differentiation of this whole makes him increasingly dependent on it. Natural Selection therefore tends to accentuate the qualities that make for tribal, rather than for individual, survival. Now, tribal strength is expressed in mutual dependence and

union, in loyalty and courage, and in the exercise of these qualities the individual comes to subordinate his personal advantage to that of the tribe, and so tends to ensure their survival and development. Those qualities tending to the advantage of the community, and so secondarily to that of the individual, are taught and practised from generation to generation till they become inherited habits. In the end their utilitarian character takes on an aspect of authority. Man, in virtue of his conceptual powers, formulates rules of conduct which serve as the collective morality of the tribe, observances which are respected now as duties, and as such conscientiously performed. "Ultimately our moral sense or conscience becomes a highly complex sentiment—originating in the social instincts, largely guided by the approbation of our fellow-men, ruled by reason, self-interest, and in later times by deep religious feelings, and confirmed by instruction and habit" ¹

Ideas closely related to the above have been expanded into systems of scientific ethics by Clifford, Spencer, and others ². Broadly, however, they come under the same limitation of presenting the development not so much of morality as of its physiological basis, of giving accounts of the external aspects of moral progress and of the development of the apparatus of the moral nature, but not accounting for morality. Darwin gives suggestive descriptions of the origin of definite instincts, and then says that they comprise man's moral nature. But is it possible on such a view to state broadly which instincts go to constitute that moral nature, and at what stage others which were not initially so constitutive, became so?

We can see that, in its earlier stages, moral character—and especially is this true of all those elements that are distinctively social in their expression—may be subjected to Natural Selection much as physical characters. The fact, however, that it is possible to trace the development of morality does not necessarily imply that that develop-

¹ *Op cit* p 203

² Cf more recently *The Origin and Development of the Moral Ideas*, by Edward Westermarck, and *Morals and Evolution A Study in Comparative Ethics*, by L. J. Hobhouse

ment has throughout followed the method of development of physical characters. In the case of the latter, Natural Selection has played a very important part. But in the case of the former, just in proportion as the character becomes distinctively moral does Natural Selection cease to have to do with its development. The moral character is like the student that has passed beyond the capacities of his early instructor: the latter ceases to have any hold on him. It is impossible to indicate the precise point where the change is effected, just as in the case of the development of other critical capacities. The early stages are forwarded by Natural Selection, but a point comes where the individual takes a direct and active part in moulding and fashioning the characters in question. This abrogation of Natural Selection is clearly visible, as Professor Sorley maintains,¹ at that stage where sympathy and benevolence, universally established, continue to grow and expand, although that growth as universal is no longer of the character of a survival-determining factor, inasmuch as no particular community is being benefited by such exercise at the expense of others. In fact, on theoretical grounds the opinion might be regarded that such a growth would be an element making for elimination. The characters in question grow and become more general, but not as the result of a natural selection, where all show them in the survival-determining degree. They grow and become more general, and in precisely that degree do they eliminate the possibility of that rivalry which is of the essence of Natural Selection. It is perfectly possible to describe the differing outward expressions of morality that have characterised successive stages in human evolution, but the notorious failure of many attempts at explanation of the ways in which savage races behave to-day makes all theorising with regard to past conditions very precarious, whilst the endeavours to deduce or construct from such an evolutionary account of morality something of the nature of an ideal or end of conduct now, is a task of superlative difficulty. To associate it, *e.g.*, with the most persistent impulses in human nature—

¹ *Ethics of Naturalism*, p. 153

those that have been productive of the most abundant and most harmonious life—is to take that ideal from the past, but to find an ideal in the past is to surrender the idea of progress. As with every character physical or spiritual, the real problem is not that of survival, but of arrival, not of persistence, but of origin. Here the initial crisis seems to be directly dependent on the dawning of self-consciousness, and that reflection upon ends that constitutes a new dimension in which evolution thereafter proceeds. Again, there is no absolute break, but there is the emergence of a new phase of evolution, when the individual in conscious relation with the spiritual environment participates directly in the progressive movement. “If I were called upon to exhibit the chief determinants of human life as a single chain of causes and effects. I should do it thus. Working backwards, I should say that culture depends on social organisation, social organisation on numbers, numbers on food, and food on invention.”¹ At either end of this simplified series of determining elements in human life is a spiritual factor—the tool-using capacity that is so characteristic of man,² culture significant of mind. In accompaniment of all this, morality evolved, being shaped by human beings even yet in process of acquiring freedom of will and in the way to attaining individuality.

As the result of notable investigations we have learned a very great deal about the development of morality. Yet after all, moral character represents but a certain way of struggle—a method rather than actual quality, measurable and determinate. There is no such thing as goodness in itself, but there is good thinking, good living and good serving. Accordingly the origin of customs presents no difficulty in a sense, for ultimately they simply represent different *kinds of ways* of doing things. Customs are forms of social activity synchronous with human life, what we want to learn is why one way of doing the same thing rather than another way was selected. If the “primitive moral idea is simply a

¹ R. R. Marett *Anthropology*, p. 155.

² Cf. emphasis laid on *Homo faber* by H. Bergson *Creative Evolution*, p. 146.

subjective reflection of the customs of the tribe," which, sanctioned by tradition and representing that which every one did, had "its echo in the consciousness of the individual as the standard of right,"¹ we want to know why it took one particular form rather than another. It is said of the original Tasmanians that they had no abstract terms in their language, *e g* for right and wrong, but that does not mean that in their actual life they did not recognise certain actions as things to be done and certain others as things not to be done, *i e* as right and wrong. No tribe will ever be found without the rudiments of morality, without customs, because these represent fundamental distinctions, different ways of doing things that were a part of life itself. To reflection alternatives, in some cases numerous possibilities, are always open, and religion, which was at first intimately associated with morality, is a distinctive human characteristic to which it is foolish to look for analogies in the lower creation, as it implies amongst other elements the power of reflection. Nothing is more distinctive of man than his religious capacity, that attitude of mind which, in its recognition of dependent vital relationship to a more fundamental Power, controls conduct. Conceivably, certain of the elements that comprise the religious attitude may be traced in a modified degree to the lower creation, particularly in such mammalian forms as have been closely associated with man, but in default of the power to comprehend a universal, it is playing with words to attribute religion to the lower creation. Religion expresses awareness of the essentially spiritual nature of man, and of the natural desire for linkage and communion with the Spiritual Source of things. It is the origin of that initially groping outpush which we call faith, those spiritual tactisms that alone rightly orientate human life.

Human morality, as we have seen, is not a constant. The values have changed in the course of history, the criteria are far from uniform in different parts of the world to-day. Yet it is the highest developments that

¹ "Evolutionary Ethics," by W. R. Sorley *The Quarterly Review*, April 1909

must be considered in any explanation, and it is these that give the clue. Even when we have traced in actual detail the successive stages in the evolution of morality, that would not invalidate the fact, which after all is the only important one, of our possession of such a nature, or in any way modify it, *quâ* moral nature. If conscience has a natural history, it is none the less conscience. If incipient morality can be traced in lower stages of life, that does not make it any the less morality in the higher. But as a matter of fact, "the further we go in examining any naturalistic theory of ethics, the clearer does it become that it can make no nearer approach to a solution of the ethical question than to point out what courses of action are likely to be the pleasantest, or what tendencies to action the strongest, and this it can only do within very narrow limits both of time and accuracy. As to what things are good, it can say nothing without a previous assumption identifying good with some such notion as pleasant or powerful. The doctrine of evolution itself, which has given new vogue to naturalism both in morality and in philosophy generally, only widens our view of the old landscape. By its aid we cannot pass from 'is' to 'ought,' or from efficient to final cause, any more than we can get beyond the realm of space by means of the microscope or the telescope."¹

However we may explain morality in association with inherited instincts of racial good, however we think of race instincts of the general good slowly obtaining the mastery over the individual instincts associated with pleasure, however we may finally conceive of conscience as the insistence of the cumulative racial experience of the beneficial and injurious, yet there remains the fact that this conflicting issue between the racial and individual interest can never have been settled initially as the result of the experience that it would lead to most abundant life. The will-to-die often involved in such subordination of personal advantage to the good of society as in the palæolithic prototype of a Father Damien can have involved no knowledge of such good, and must have often actually resulted in the

¹ W. R. Sorley, *Ethics of Naturalism*, p. 326

individual's death the adoption of that particular method of struggle did not, at any rate, repay *him*. So, once again, to maintain that evolution supplies its standard of morality in what actually survives as the result of Natural Selection is to ignore much in the physical zone of the environment that is unaffected by that factor. It is wholly to forget that the demands of the psychical zone have often led to the immediate physical extermination of those who yielded to them, but by that very circumstance the ideals in question gained a wider recognition and led to the survival of the race.

Such type of action cannot therefore find its explanation in any instinct due to a racial experience of what is advantageous or disadvantageous. It can only have been undertaken under the direct stimulus of that spiritual aspect of the environment in communion with which all psychical progress is made, and whose realised insistence is the "ought" of human endeavour. Such a response whenever it occurs will doubtless include as result the ultimate preservation of that in other lives for which the sacrifice is made, it has even meant directly the preservation of the race. It is not necessary to suppose that in the earlier stages of the development of morality, any more than to-day, such a response was given by any great numbers of individuals. The modern investigator may give an account, speculative or otherwise, of the meaning of those objective expressions of morality that take the form of tribal customs, but it seems probable that this meaning, however true, is known to but few of those who observe the custom. In many instances it has become a tribal habit, and persists as a survival. Yet the breaking away from that custom, as also its origination, was the result of some commerce with the spiritual environment on the part of the individual or individuals who instituted or dispensed with it. In imaginative reflection partly—the result of the working of some objective datum in the mind—the new custom arises, how exactly the suggestion comes we do not know. That it should be initially in great part often debasing presents no difficulty to those who

believe in the ascent of man from an animal stock. Later, the feeling or emotion resulting from such commerce may be purer than its expression. But to seek the origin of the response simply in physical aspects of the environment, or in some development of past social instincts, to strive to find the explanation of that which is of higher moral worth than anything known up to that point in previous stages, whose characters were increasingly animal, is to repeat in its most disastrous form the old error of considering the developing organism apart from its environment. The moral nature in correspondence with God develops until it reaches a stage where the organism is meaningless, apart from the highest development of its being.

CHAPTER XV

EVOLUTION AND EVIL

THE problem of evil has baffled men from the beginning. In its direst form, that of moral disease or sin, it has miserably defeated all human efforts to cope with it. To deny its existence is something worse than affectation—it is moral suicide. To say that “the higher man of to-day is not worrying about his sins at all,”¹ is simply to refer to an insensibility, a numbness that is the sure forerunner of spiritual death—to find satisfaction in the fact is not to befriend humanity.

Evil as we know it and as commonly conceived, appears in two aspects, the one physical, the other moral. Much of the former is directly due to the latter, as may be seen in any hospital. Indeed, apart from sin and its direct and indirect consequences, the problem of evil is not wholly unmanageable. In fact it is largely a relative effect, receiving content and expression in the relativity of all phenomena. Thus consciousness notes relations as knowledge, but these relations are revealed through differences. Without relativity of sensation there would be but monotony of sense-perception, in which nothing could be distinguished. A monotony of sound would ultimately fail to arouse the sensation of hearing. Truth would not be perceived to the same extent as truth, were there not falsehood. So evil may arise as the result of faulty and imperfect expression on the part of phenomena, for everything that enters the phenomenal world is subject to limitations. It may also arise too easily from failure on our part to really understand and orientate phenomena.

Further, all manifestation of energy involves a certain

¹ Sir O. Lodge, *Man and the Universe*, p. 220

overcoming of some reluctance or resistance As soon as resistance is developed the force comes into play—a steamer would make no headway without the resistance of the water No activity is manifested save as pulses of resistance being overcome Withdraw the resistance and the power is impotent No doubt, electricity, if it could think, would regard the inert resistance of the carbon as an evil to be overcome, but in the overcoming the electricity is revealed and self-realised Physical evil is a real thing to *us* in the process of the attainment of goodness, but it is the attaining which is the most real and necessary thing Evolution, in its insistence on the essentially dynamic and developing character of the world process, saves us from the necessity of attributing any absolute character to physical evil

So far as the organic kingdom is concerned, pain and disease are the common heritage of man and brute alike, by reason of their sentient bodies We have already realised what is involved in the capacity for pain,¹ and the extent to which it operates as a factor in organic progress In human experience pain has often proved to be God's kindest schoolmaster, hardship and affliction but courses in a divine curriculum of Love² In the tribulation of pain the individual and the race have learned more about the real value of life than in the ecstasy of pleasure And the more one thinks of it, the more difficult it is to see how spiritual beings could have been trained in character worth the name without those particular methods It is not so much the untinged sense of pain as contrasted with the too commonly isolating sense of happiness that makes us reconsider the relation of pain to evil,³ it is the fact that the thing that is thought to be evil can be transmuted into the fibre of a better, nobler being by the self-controlled, determined, and trusting heart that places itself in the right attitude to it

With moral evil the case is otherwise, particularly as regarded from the point of view of the fully developed

¹ Cf p 131

² Psalm cxix 71

³ *Hibbert Journal*, vol vii p 129

consciousness Here it cannot be *explained* in the sense that physical evil can, it is more absolute than relative Nevertheless a certain development can be traced in relation to it Nothing, indeed, is more obvious in history than the progressive raising of moral values, so that practices which at one stage were good as compared with those of an earlier period which they have supplanted, yet in turn become indefensible, and are discontinued in the fuller knowledge and heightened moral sense of a later period To realise this is not to minimise or deny moral evil It is indeed an element in the process, but not the most real element nor the most imposing one Reality appears as a process in which even moral evil is being progressively overcome

Our problem, however, is the account that will be given of the origin and implications of sin in the light of Evolution Now this compels us to distinguish clearly what we mean by the word "sin," for failure to do so has been the cause of much misunderstanding In the Shorter Catechism sin is described as "any want of conformity unto, or transgression of, the law of God" This must be held to imply a conscious moral agent (otherwise the word is logically applicable to the actions of the innocent child, the untutored savage, and the man-eating tiger) it further implies a law, and knowledge of the law "Whosoever committeth sin transgresseth also the law for sin is the transgression of the law,"¹ "where no law is, there is no transgression,"² and where no knowledge is (i.e. of law), there is also no transgression Had these simple truths been fully realised from the beginning of theological thinking, much of the confusion with regard to this dark theme might have been avoided For not merely does sin imply knowledge, but its source and secret being lie in the human will There is no such thing as sin apart from sinning men and women Its apparatus and arena of operation are found in our human nature its essence is the selfish misuse of elements that in themselves are not inherently bad, but are rather neutral and unmoral Sin and sinful are ethical terms, and should not in

¹ 1 John iii 4

² Rom iv 15

strictness be applied to other than the apostate will, nor predicated of a nature that supplies impulses, which, in their direction and misdirection only, are good or bad Sin, that is to say, is not merely a distinctively human character, but is conditioned by the stage of human development. Nevertheless it is a word of such limitless content that we might well assume that in some of its aspects we should find analogies in characteristics of the lower creation. As a matter of fact we do, and it is this circumstance that gives such power to certain passages in Henry Drummond's *Natural Law in the Spiritual World*. Few who have read the chapters on Degeneration, Semi-Parasitism, and Parasitism can ever forget them. Sin viewed in relation to its own character stands out as the bad and reprehensible, in relation to man and what was expected of him because of what he knows, it becomes the abnormal, the unnatural, a departure from the standard. In the serial stages of arrested development, degeneration, and parasitism, and in phenomena like reversion, we can find physical analogies in the lower creation that with startling likeness prove descriptive of mental and moral conditions of man.

It cannot be too strongly asserted that to investigate the history of the doctrine of Original Sin, or even to inquire speculatively, so far as we may, into the conditions under which sin emerged, is not in the slightest degree to minimise or explain away the terrible, the exceeding sinfulness of sin. Still less is it to question man's need of redemption. We have held that the evolutionary conception of the origin of man can in no way detract from the glory of man as he is. Similarly we assert that the evolutionary account of sin can in no way belittle its actual appalling significance. There can be no dispute about the fact of sin—that is given in modern experience. What may be questioned are certain received accounts as to the origin and implications of sin, both in the individual and in the race. And even what is questioned is not so much any strictly Scriptural account, as a particular interpretation of that account.

This interpretation, largely associated with the name of St Augustine, is to the following effect "Our first parents," to quote certain sentences from the Westminster Confession¹—"being seduced by the subtilty and temptation of Satan, sinned in eating the forbidden fruit This their sin God was pleased, according to His wise and holy counsel, to permit, having purposed to order it to His own glory By this sin they fell from their original righteousness, and communion with God, and so became dead in sin, and wholly defiled in all the faculties and parts of soul and body They being the root of all mankind, the guilt of this sin was imputed, and the same death in sin and corrupted nature conveyed to all their posterity, descending from them by ordinary generation From this original corruption, whereby we are utterly indisposed, disabled, and made opposite to all good, and wholly inclined to all evil, do proceed all actual transgressions" So far as the doctrine of Original Sin is construed as a doctrine of Original Guilt—imputational in the Augustinian sense—it has been rejected by the developed Christian moral sense of to-day indeed, it is a contradiction in terms It belongs to a period in which the value of the individual was as yet undeveloped The conception of the solidarity of the human race may help us as we strive to realise the universality of sin it helps us not at all with a theory of universal guilt as extending over men from one man's sin So far as the doctrine of Original Righteousness is concerned, it is too speculative a superstructure to rear upon our first parents' ability to react to a command, and their awareness of their nakedness Even were it granted, the successful instigation to sin as a psychological fact under such circumstances raises a problem very difficult of solution, while the idea of a single isolated initial act with such disastrous racial consequences, is unassisted by any analogous experience in the developmental psychology of to-day Finally, a doctrine of Original Sin, while helped by our sense of the solidarity of the human race, finds that assistance only on the physical side where it is of least assistance

¹ Chap vi

those nodes of individuality that we considered as rising out of the physical stream of life have no genetic relation to one another. Indeed, all forced correspondence of a doctrine of Original Sin to some inherited corrupt nature reduces the former to an aspect of physical evil.¹ At the same time we have to find some explanation of that in relief of which the doctrine of Original Sin was promulgated, namely, the paradox of experience between the sense of personal responsibility for sin and the feeling of an innate bias towards evil.

A true doctrine of sin connects itself with a view of man as a highly developed personality. The consciousness of sin varies with the individual expressed as crime, it is graded by the penal code. In every aspect of it there are the basal principles of selfishness and lawlessness, which may differ in degree. As the individual becomes growingly aware of the beauty of holiness, his sense of sin deepens. Progressively it has a history at no stage is there a cataclysm. The expanding antiquity of man enlarges the time area within which the development of every quality that characterises him took place, and as this is realised, the difficulty in positing any exception to the gradual development of his faculties will be intensified. The evolutionary conception compels us to think of his gradual emergence from the purely animal, a creature of impulse, unmoral, unrestrained, unconscious of the idea of control. We speak of the baser passions so far as they correspond to animal instincts the baseness consists simply in the lack of control. Sin is a corollary of knowledge, but it is the frequent exception to the truth that knowledge is power. The Bible is profoundly right in pictorially conceiving of the entrance of sin as due to eating of the tree of the knowledge of good and evil.

The reconstruction of those ages of incipient morality is of course for ever impossible, harder even than the task of tracing the evolution of mind. There are no concrete expressions of such morality, as in the case of mind, till very long after it is there. None the less

¹ Cf. F. R. Tennant *The Origin and Propagation of Sin*, p. 38, also throughout, *The Concept of Sin*, by the same writer.

we may be sure that in the tumult of instinctive life, associated as that must have been from the beginning with intelligence, moments developed when the mechanism worked less smoothly, the mental reactions were not so immediate, and in those slower moments was developed that which ever after altered the whole character of the movement. Man in that morning *Götterdämmerung*, with his incipient consciousness of self and awakening moral sense, became aware of the possibility of choice between alternatives, and knew these alternatives as higher and lower. Sin entered through deliberate voluntary acceptance of the lower—that is the historical fact. It was that which had been done often before in innocency of anything higher, but so far it was not sin. In persisting in doing that which he had formerly done, now knowing it to be lower and aware of other possibilities, he sinned and fell—fell back from the realisation of life on a higher plane. Having made his fatal choice, he was immediately overcome by a sense (necessarily germinal), of remorse, and knew in himself that he had been for ever banished from his garden of innocence.

Such history as we have enables us to trace in part the slow development of individuality. So far as the study of contemporary savage life assists—and the assistance is much less than is ordinarily conceived, for no modern savage tribe represents the unchanged descendants of any form that once stood in the direct line of human ascent—or the oldest historical documents attest,¹ we obtain first-hand witness to states of society in which the tribe is the unit, the tribal instinctive custom the sole yet scant inhibitor. Group action signifies the failure of outstanding dominance: no individual has succeeded in that long continued victory over impulse which would work a new departure. The reflecting mind has not attained that steady inward turning of itself upon itself, without which there could be no awareness of alternatives as higher and lower, and which is therefore the prerequisite of all moral advance. conscience implies self-consciousness.

¹ e.g. Joshua vii 15, 24

An external descriptive account can, however, in no way even summarise the inward process in virtue of which advance took place. Even could we be sure of the particular initial moment in which an individual became first aware of alternatives of conduct as higher and lower, and voluntarily chose the lower, it would be difficult to affirm that sin definitely entered at that moment. The action was certainly sinful, but the entrance and victory of sin has never been a momentary affair, it is an age-long process, alike in its origin, its persistence, its elimination. Yet is there nothing necessary or inevitable about it. We may discuss the origin and implications of sin, never its origin and function. It was no necessary stage in the development of man. The struggle is inevitable, not the fall. He might have overcome in the beginning, he might have followed the gleam. The instinctive impulse and appetite, strong in some cases because of their basal utility to life, the conscious desire when faced with the dawning recognition of a higher if more difficult way, present the arena for struggle and resistance. As when the electric current is turned on, and the arc lights flicker and burn unsteadily till the power avails to transmute the recalcitrant material, so the darkness of man's early life was only gradually and fitfully illumined. That there was a return to darkness at all after the initial flash is the statement of "the Fall."

But if the racial records can help us little in dealing with what are really prehistoric moments, and the evidence from contemporaneous savage man is difficult because in fact irrelevant, there is a line of enquiry to which we may turn with expectation. For if the Recapitulation Theory holds any truth in its interpretation, we should expect that it will not fail us here, and particularly impressive will be its verdict in the physical field if we should find that in the subtler arena of the spirit, the data as we read them prove in accordance with the general line of interpretation. Now every honest man who reads the third chapter of Genesis feels that it at any rate describes his individual experience. For, as a child, there was a golden age of innocence.

in his life, but one day temptation came, and he fell. Consequently it is not impossible but rather probable, upon biological analogy, that the childhood of the race was lived in innocency, that then a day came, when a cloud hid the sun. To this we may add the testimony of many men, good and bad alike, to a feeling of uneasiness and of dissatisfaction in view of the fact of sin, to a feeling that they are not what they ought or were intended to be, to a sense that they have in them some disposition that hinders the accomplishment of the resolves of their better moments. "I find then the law," said St. Paul,—and he spoke for many a man,—"that to me who would do good, evil is present." ¹ That is to say, he has the feeling that the present state of matters, this inner warfare, is not the right or natural one, that this "body of death" in him from which he prays to be delivered, is an acquired character—acquired, however, by himself.

What is the character of the genesis of sin in the individual life? It is an easy prophecy that every development of child psychology and morality will only serve to bring the ontogenetic story into closer agreement with what we are driven to think of as the racial history. We have already realised how slow is the dawning of self-consciousness, how the child is first a bundle of sensations, how consciousness arises, and only later on are the final awareness of self and its assertion in the will attained. Particularly do we see the emergence from the impoverished instinctive phase in the faculty of imitation, through which the child would go beyond itself and ally itself with other forms and forces. Similarly we are compelled to recognise a stage in which it is the slave of impulse. Out of this it passes, as the moral consciousness awakens. Everything has to be learned by the child, and in those early days of non-moral miniature animalism and later savagery, we seem to have the recapitulation of the story of the race. How long we wish they might remain in the garden of their innocence, but a day comes when knowledge of good and evil is attained, deliberately

¹ Rom vii 21

the lower is preferred, and they are banished from the garden. And the reason why this failure is persistent and has met with only one exception is not because some ancestor failed. Sin is not an ancestral affair, it is a personal affair¹. The others have failed for precisely the same reason that he failed—the difficulty of that struggle with the lower self that yet comprises the inwardness of life, and is the secret of all progress. The characters are there—impulses and instincts—that made for survival on the lower plane, but as the Environment becomes unmasked and the individual grows more aware of the possibility of some new conformity, and realises that his survival now depends on control of what was formerly unchecked, these impulses come to be regarded differently and are the arbiters of his fate in a new way. If the choice is made in one direction with any degree of uniformity, habit makes it easier. The moral elements are like many physical elements: their character depends upon the use that is made of them. Fire and water may work to man's improvement or to his destruction. Around the lower appetites develop the fairest blossoms of human character or its most degraded expressions; and even those other features that are more purely spiritual have possibilities of good and evil according to their usage and their development. Sin emerges only with the will, and consciousness of alternative action: it is the surrender of the self to the lower dictate, acquiescence in the old state of affairs, failure to struggle towards the higher, treachery to the recognised purpose of the whole. Subduing of self, the aligning of conduct with the glimpsed ideals of the race—always initially an individual matter—therein lies the struggle, for impulse is instinctive.

¹ It is surprising to find the view of the "individual nature of sin" characterised as "curiously out of date" (E. J. Bicknell *The Christian Idea of Sin and Original Sin* p. 34) on the ground that "in the late war we held Germany as a whole responsible for gross outrages against humanity". This is precisely what many people did not do, knowing that the phase of political evolution in which it is possible for a majority to crush a minority into silence is being outgrown. Further there is no "corporate mind" that is anything more than the accepted expression of some individual mind by other individual minds.

and chafes against control. The mere recognition of the possibility of restraint issues in lawlessness, a natural state of rebellion by the hitherto uncurbed spirit. The curbing has been removed from the external physical sphere to the internal and spiritual. It is a change of control, with awareness first of the fact and then of the necessity of control, and the change has arisen as a result of the reaction with that Environment which in its proximate aspects is physical but in its deeper essence is spiritual. The community of life, involving community of tendency and so of struggle, has as its corollary the universality of sin. Once reason had arisen with its possibilities of permutation and combination in impulse and motive, it enormously extended the area over which sin could develop, till it becomes nothing less than moral disease.

Such, then, is the view to which the evolutionary conception leads us. From the history of evolution we learn to think in terms of a gradual progressive advance, not of such cataclysmal reversals or alternations of advance and retrogression as the older view suggests. It shows even within the strictly historic period definite progress in religious idealism, and we cannot be wrong if from what we know of this curve of advance, we extrapolate it into the eras where knowledge is not so available. The religions of to-day contain vestigial remains of their earlier stages, as did the Hebrew religion, language and customs still hold within them evidence of their prehistoric stages. Yet from no quarter do we get witness to a stage of primitive goodness or high culture from which later stages represent a persistent fall. The more we learn of the history of the race, the more does the idea of a lapse from a clear consciousness of God and perfection of relationship with Him into a condition of universal savagery become unthinkable. Such a conclusion may perhaps appear more revolutionary than the change in our views of the interpretation of the Creation Narratives. At any rate it demands a further investigation, and, as in the other instance, we shall best help ourselves by returning to the original text, and endeavouring to learn exactly what it teaches.

In Genesis ii 4-iii 24 has been preserved the Biblical account of the origin of sin, an idyll of haunting beauty and pathos that Gunkel rightly describes as "the pearl of Genesis". Unfortunately, as in some other cases, the simplicity of the original story and its deep moral truth have been overlaid with wrappings of later theologising foreign to the original account, and productive of seeming inconsistency with the only less vital truths that have been won by the slow progress of science. This narrative by J, the critic tells us, contains a story which, though not strictly paralleled in other Semitic folklore, still has Babylonian affinities, a story that gives no piece of scientific anthropology, whose age is but as yesterday compared with the proved antiquity of the human race, yet tells us that which every man can verify in the forum of conscience. How largely it has been overlaid with later extraneous significance may be gathered from the universal identification of the serpent with the Evil One, of which there is no trace in the narrative, by assertions of original righteousness about those who were indeed living in childlike innocence and purity but had no knowledge of good and evil, and by failure to realise that in the narrative itself there is distinct recognition of a dawning moral sense which has to be stimulated by the imposition of a command. The consequences of the transgression are visited on the sinners' posterity, but there is nothing in the Old Testament to show that this sinful tendency is so regarded.¹ Even the wonderful proclamation of perpetual enmity between the seed of the woman and the seed of the serpent has not strictly the direct promise of ultimate victory that is so often read into it. All that we can literally gather is a tale of lost innocence² resulting from wilful disobedience to a command that is the kernel of the story. Scripture is commonly supposed to teach that mankind fell from a state of original good-

¹ St Paul's statements in Rom v 12-21 (especially vv 12 and 19) on the relation between the sin and death of Adam and that of his descendants were apparently derived from some uncanonical Jewish tradition, his real interest is in the fact that all "they that are Christ's" shall in Him "be made alive" (1 Cor xv 22, 23)

² "They knew that they were naked," Gen iii 7

ness the study of man indicates that his "fall" was rather failure to become that which he ought to have become, interference on his own part with his normal development. However diverse the two readings may be superficially, they agree in their representation of this moral crisis as the consent of the spirit to evil in the form of self-indulgence and self-will.

Concerning this stage of original righteousness, and more particularly of that high degree of culture and intellectual gift that are commonly associated with our first parents, it certainly is not Scripture that warrants us in so thinking. How far Milton is again responsible for the culture attribute is a fair question. With regard to the other character which has greater theological bearing, we may note that even St. Paul, while perhaps connecting the sinfulness of the race with the sin of one man, yet does not speak of him as having previously lived in a condition of original righteousness. The traditional view represents a being of noble character and definite knowledge who yet does not know good from evil, and who, as the result of an imperious desire to know, is driven out into the long night of Palæolithic and Neolithic experience. Such an interpretation violates not merely Scripture and history, but the moral sense.¹

In any attempt to picture to ourselves primitive man, both physically and mentally, we must not suppose that we find his replica in the lowest races of to-day. Both mentally and morally he must have been very unlike them. All that is praiseworthy in them would certainly have been found in him, but further, there was in him the potentiality of all that has come to desirable fruition in every aspect of life, social and individual, to-day. In him lay that capacity for progress which

¹ It is of some interest to note that if J gives us a historical account of man as originally sinless which however is open to doubt he himself does not connect this sinlessness with the divine image in man. In fact J nowhere mentions the divine image. That occurs only in P (First Creation Narrative) and when P mentions it, there is no corresponding reference to sinlessness. That is to say, the conception of original righteousness is nowhere connected with the divine image by J nor, on the other hand, is the divine image connected with sinlessness by P.

has evaporated in the set modern savage races, whose immobility can only be melted or influenced by external impulses. And yet he might have become something better.

Man alone is the author of sin, nevertheless the presence of moral evil as that which is absolutely antagonistic, contrary to the character of God and hated of Him, has often been felt to be an indictment of the divine omnipotence. All expression is, however, limitation, and in the creation of this world, peopled by free-willed human beings, we perceive a self-imposed limitation of the Divine Spirit. In such a world, indeed in any world of moral implications, was involved the possibility of moral evil—a possibility that cannot have been unforeseen, but for its actuality the sinning individual alone is ultimately responsible in every case. The divine purpose evidently admitted of the possibility of sin, but in no way entailed it. Sin we cannot believe to have been any direct part of the divine purpose—it is a subverting consequence of the gift of freedom. About that purpose we can be tolerably certain, for the end of life is the formation of character, the development of strong and virtuous spirits which may be meet partakers of His glory. How this could be achieved without the exercise of freedom it is impossible to imagine, and through such freedom sin entered, but having appeared, it gave God the opportunity—an opportunity that would not have been offered in a sinless world—of revealing Himself in that fundamental manifestation of self-sacrificing love. In the stresses of our human lives caused by evil and by our own sin, is given the opportunity for the manifestation and realisation in us of the redeeming spiritual forces of God's love.

Man has to overcome himself, to set himself free from the domination of the lower motive, to win and develop the will to do right. In increasingly intimate correspondence with the spiritual aspect of the Environment lies the secret of progress for humanity. In man's nature there is the inertia of his animal ancestry, corresponding to what was considered to be the bias of Original Sin. There is the wilful opposition to be

overcome, the possible contingencies of a growingly free will. As the individual overcomes the grosser forms of this resistance he becomes more sensitive to its finer and more subtle forms. Possibly there will always be something to be overcome. Yet we may believe that in the reaction against evil, human freedom will increasingly take on the form of goodness, and man thus be brought into gradual likeness to God.

CHAPTER XVI

SCIENCE AND MIRACLE

THE conflict between the supposedly scientific view of things and the religious conception of the world has always emerged particularly in connection with the idea of "miracle." The latter term has usually been defined in this connection as an event contrary to, and so involving some breach of, the continuity of Nature, directly attributable to God, and brought about in face of some exigency in the process of revelation. Miracle was therefore conceived as something that transcends our experience, and as therefore in great measure unintelligible. A contrast accordingly developed, with the advance of knowledge, between a purely mechanical view of things where all is determinate and calculable, and a view of matters under which God might do any kind of thing at any time, and these two outlooks were held to be mutually inconsistent. As a matter of fact, neither has ever represented the truth. On the one hand, God is limited in His activity by His nature: there are things that God cannot do. On the other hand, while the mechanical view is of the core of Naturalism, it has yet to be shown that it supplies an absolutely true and complete account of Nature. By the uniformity of Nature, no more is meant than that under the same conditions the same results will follow: it is a generalisation based upon our very limited human experience. But the whole essence of the conception of evolution, creative and broadly progressive, implies strictly that the same conditions not merely do not, but cannot, recur. There is therefore straight away a certain antinomy between the two statements, sufficient to show that any view of the world-process as a closed system

is false, and allowing all the loophole required for the inclusion of what may be conserved under the term "miracle," in what on other grounds is perceived to be essentially a spiritual process

At the same time the fact that miracle has been defined as an event contrary to our experience of Nature does not, even on that definition, preclude its possibility. Indeed the whole conception of the world beyond our senses for ever shows the unscientific character of the dogmatism that categorically asserts that miracles do not happen. It is obvious from this illuminating idea that what is not known or regularly experienced, must be so infinitely more and vaster than the things we do know, that in dealing with the great conceptions of God and the Universe and their relation to one another, all that the man of science can tell us is comparatively little. His realisation of the definite limitations of the instruments whereby the data for knowledge may be acquired, and his sense of the small proportion of impinging stimuli to which his sense-organs can respond, compel him to admit the infinite possibilities of phenomena with some of which, constituted as we are, we can possibly never come into relation, some of which we become cognisant of by means of such added sense as the galvanometric test, some of which we may become aware of in supernormal conditions of our mind or receptive organs, but which nevertheless are continually hinted at in experience, and may very occasionally be realised in exceptional circumstances. The discovery of argon or of the Rontgen rays does not mean that these phenomena came into existence for the first time at the moment of their discovery. They were there all along, exerting their definite though unrealised influence until the time of their manifestation.

It should, however, be carefully noticed that this is not to adopt the mistaken attitude of an older apologetic, and base the argument for divinity on our ignorance—and so find God in the gaps of our knowledge, or see Him only in the bizarre. Religion has suffered from the adoption of this attitude, whose natural consequence was that, with the spread of Science, God was banished

from His world. Take the case of any great discovery—knowledge is ordinarily acquired in instalments. At the first stage the conception of it might be represented by $a+x$, where x , the unknown=God. The next stage might be represented as $a+b+x$, but as the series $a+b+c$ grows, x becomes a vanishing quantity. The ideal of Science is to get rid of x , i.e. the unknown. Or in particular illustration, we may suppose that a savage tribe in days gone by explained the phenomenon of a solar eclipse by supposing that God covered the sun with a blanket. This would be an explanation wholly in terms of x . Later, under the Ptolemaic theory, a scientific explanation of the same phenomenon would be given not wholly complete, and that we might represent by $a+x$, where x would represent the mysterious, the unknown=God. Under the Copernican theory we may be said to have an explanation that is represented by $a+b$, complete in itself. But does this necessarily mean that there is no x , that God is driven from His world? By no means. The mere fact that in terms of $a+b$ we can predict that the next total solar eclipse visible from any part of the British Isles will take place on 29th June 1927 gives us a new conception of "the Father of lights, with whom is no variableness, neither shadow that is cast by turning." We win back on a higher plane our sense of divinity in thus realising the stability of law, the essential soundness and solvency of the universe. A more correct representation of these phenomena would be $\frac{a+b+c}{x}$ where x might represent the ideal of the divine immanence—the continual sustaining and control of all things by God.

Again, with regard to the scientific attitude towards the interpretation of miracles, it will be allowed that Science cannot deal arbitrarily with anything that cannot be fitted into the network of relations and uniformities as known at any definite period in history. That which is, provided it be duly authenticated, even if it be unique, is a tyrant before whom all laws must yield for their restatement, for laws have their validity and their utility alone in virtue of things which are

298 SPIRITUAL INTERPRETATION OF NATURE

Nothing happens through law, though everything happens according to law. The law as known while indicating something regulative of Reality, yet tells us nothing of what is essentially constitutive of Reality.¹ Natural Science is powerless to tell us how in general it is possible that anything happens, or what all can happen. There is nothing of which we can say that it is contrary to Nature though it may be contrary to our knowledge of Nature, since we do not *know* the real Nature of things so far as it comes under observation as all-effective Energy, and we are therefore unable to gauge the possibilities of its productivity. The man of science must never assume that the limits of his methods are the limits of Reality. In a progressive system, indeed, that which is can never be regulative, or afford a complete account, of that which may be. It is not common sense to urge an argument against miracle on the ground that in it we have something which is contrary to experience, and which is therefore inherently incredible. The whole history of the evolutionary process is a history of advances not so much contrary to, as transcending, any possible experience in the previous stages. This we may make clear to ourselves by imagining some Martian coming to our planet for visits sufficiently long to give him real terrestrial experience, and yet at sufficiently removed periods to let him realise the extraordinary range of evolution in our planet's history. Thus, if he had insinuated himself into terrestrial conditions during the palæontological eras that were successively dominated by mollusc, fish, reptile, mammal, and man, he would in each of them have made acquaintance with much that was contrary to, or incompletely accounted for, in the terms of his previous experiences—much, in short, that was new, owing to the fact that he was in the midst of a creative process. But all this is just as we should expect so soon as we have satisfied ourselves that the world process is ultimately spiritual and teleological, *i.e.* over the whole progressively moving towards an end.

This will be the more readily admitted in proportion to the degree in which Science actually recognises the

¹ Cf. A. W. Hunzinger, *Das Wunder*, p. 107

incompleteness in the statement of her laws. There is always the possibility that the true law in its full complexity might include the isolated miracle.¹ As a matter of fact, many "laws" do not hold beyond a certain range, and in that measure are incomplete statements. Thus, in 1662 the Hon. Robert Boyle published the experimental fact now known as Boyle's Law, namely, that the volume of a given mass of gas, kept at a given temperature, is inversely as the pressure, or, in other words, the density of a gas, at constant temperature, is proportional to the pressure. However, this law is only approximately true, for while Regnault showed that for low pressures, air and nitrogen are more, and hydrogen less, compressed than if the law were true, Natterer demonstrated that at very high pressures air and nitrogen and hydrogen are all less compressible than the law requires, and deviate the more from it the higher the pressure. The law does not negative these facts; they indicate its incompleteness as a statement, its mere approximation. The true law is more complex than the simple relation that bears the name of Boyle's Law. The mere fact, then, that we are dealing with a developing process would seem to imply the emergence of new uniformities, or an enlargement in our understanding of the range of operations of the old. Accordingly, it is not surprising that doubts are entertained with regard to the applicability of such magistral generalisations as the conservation of energy to the whole universe,² or that growing expression should be given to the view that

¹ In partial illustration of miracle as a regularly unique phenomenon may be cited the peculiar relation of the density of water with varying temperatures. When the temperature is at 212° Fahrenheit—the point at which, under normal pressure, it is transformed into steam—the density is at a minimum. As the temperature falls, the density increases until at 39.2° Fahrenheit (4° Centigrade) it reaches a maximum. From this point down to 32° Fahrenheit, water expands; it becomes less dense, producing ice, which rises to the top, being lighter than water. Had the condensation continued through these last degrees, following some imaginary law of contraction of volume, ice would have been heavier than water and would have sunk to the bottom, with results that can easily be realised (cf. *Trans. Vict. Instit.*, vol. xlii, p. 244).

² Cf. Sir O. Lodge *Life and Matter*, pp. 21-23, G. W. de Tunzelmann, *God and the Universe*, pp. 90-95.

the laws of mechanics are not absolute, being, it is stated,¹ mere approximations in many cases, and simply false with regard to velocities comparable to that of light. It is difficult to see how progress could be associated with a closed system. Change under such conditions could only be kaleidoscopic. Yet there *is* progress in the evolutionary process.

It is, however, in face of her tremendous and certainly justifiable belief in the uniformity of Nature that Science has to determine her attitude to miracles. This uniformity the theist explains as the continual manifestation and product of the divine sustaining activity. His belief in a God who is unchangeable, who is the same yesterday, to-day, and for ever, not merely in His Essence, but in the fundamental method of His working, bears some relation to the scientists' belief in the uniformity of Nature. And whatever the interpretation of miracles may be, certain it is that miracle as a breach of law neither science nor religion knows. We have no experience of anything crashing into the network of law of which we are aware, and breaking it down. If God is *exlex*, as the old Schoolmen phrased it—outside the order of laws under which we are living and with which we are content—then we have no background for anything except chaos: we not merely have no miracles, but we have no universe, no cosmos. To say that He works according to law is only another way of saying that He is reasonable. At the same time the uniformity of Nature is in the end a mechanical conception based on a certain limited experience. The unity of Nature, which is a profounder truth, enables us to understand how she is capable both of being moulded to spiritual ends, and of revealing in herself and in man—her most representative aspect—the character of her Ground.

From the questions of the possibility and interpretation of miracles, it is natural to pass to consideration of the attitude of Science to the question of evidence. This is the crux of the matter, and necessarily textual criticism of the authorities and consideration of the

¹ Cf. *Nature*, vol. lxxxvi p. 400, G. Le Bon, *The Evolution of Forces*, pp. 6-8.

times and circumstances under which the miracles were wrought, will all have to be taken into account. We shall have to remember that all antiquity believed in miracles, and that the accounts of the Scriptural miracles come to us from an age that had no conception of natural law in our sense of the term. Even to-day, for great masses of mankind all the world over, the miracle, in the crudest sense of the term, is a too credible thing. Further, we are compelled to bear in mind that where the historian is not contemporary with the events he records, there is often a tendency in long retrospect towards enhancement and magnification of the scenes he depicts. While, then, the allowed possibility of miracle requires us to admit all the Scripture miracles for purposes of examination, yet this does not mean that all the recorded miracles are even probable. It is just here that scientific consideration of the text and circumstances will offer its assistance, showing how scant is the measure of such contemporaneity, and perhaps justifying us in our surmise that some of the miracles associated with Elijah and Elisha are possibly popular tales, or that the story of the withering of the fig tree may have come over from the realms of parable into those of miracle. So we are assured by expert authority that in the case of the Old Testament, "the events which are commonly accepted as miraculous appear upon an area over which there is and there can be no historical control, while they are not present in periods for which we have contemporary evidence"¹. It is a mistaken attitude to insist that all the Biblical miracles stand or fall together. The instructive story of the relation of Joshua x 12-14 to the Book of Jasher, shows how easily misinterpretation enters into our understanding of the Scriptures, and is a tribute to the value of the critical study of the Bible.¹ Particularly with regard to the miracles in the New Testament, we must recollect that the narratives reflect the spirit of an age that, if not without elements of scepticism, yet ordinarily "expected that Divine action would (as we should say) run counter to natural laws and

¹ Prof J E M'Fadyen, "Miracle in the Old Testament," *Hibbert Journal*, vol xxi p 741

302 SPIRITUAL INTERPRETATION OF NATURE

not be in harmony with them, and that the more Divine it was the more directly it would run counter to them. We may be sure that if the miracles of the first century had been wrought before trained spectators of the nineteenth, the version of them would be quite different. But to suppose this is to suppose what is impossible, because all God's dealings with men are adapted to the age to which they belong, and cannot be transferred to another age. We are then compelled to take the accounts as they have come down to us. And we are aware beforehand that any attempt to translate them into our own habits of thought must be one of extreme difficulty, if not doomed to failure."¹

But once again the very progress of Science makes many of the recorded miracles more intelligible to us. Every advance, *e g* of certain lines of psycho-therapeutics, all added appreciation of the close relations between the physical and the spiritual—of the power of mind over matter—help us to understand better Jesus' miracles of healing. They perhaps represent in a superlative degree the power whereby through suggestion men and women are even now cured of debasing tendencies and liberated from the prison of their fears. Such powers as He exercised no other one has to-day, or ever had, but these miracles do not violate our sense of reasonableness. Even in the cases which by some are held to show that Jesus was the child of His age (*e g* in the ascription of certain forms of disease to demon-possession) we simply have the assurance of His Incarnate Manhood, apart from the impossibility of conceiving how any effect other than bewilderment could have been produced upon those who sought His healing, by the adoption of language and conceptions other than those they knew. And while in the case of miracles like the turning of water into wine,² or the feeding of the five thousand,³ even if attested on critical grounds, what Science hesitates to accept is the apparent break in the continuity of causation, it may be remembered that in

¹ Article, "Jesus Christ," W Sanday, *Hastings' Dictionary of the Bible*, vol II p 625

² John II 1-11

³ John VI 5-14

many phenomena which are familiar to us—*e.g.* the passage of ice into water, of water into steam, the cinematographic display—there are apparent breaks in the causal series as observed or imagined by us, yet our minds, grasping the whole movement, conceive of the series as continuous. Finally, in this connection, the advance of Science means the increase of our sense of wonder in the world. It is not merely the case that many of the commonplaces of modern science, *e.g.* the activity of the Röntgen ray, would have seemed wonders—miraculous—to past generations, not merely the fact that a great part of the original connotation of a miracle was simply a “wonder” in this very sense, but as the advance of knowledge opens men’s minds, they come to realise that the whole is the real miracle, and look for miracle and find it in the whole even more than in the detail.

In fuller illustration of the combined attitude of Science to evidence and interpretation, two miracles may be briefly considered, drawn one each from the Old and New Testaments. In Exodus xvi 14, 15, 31, and Numbers 11 7, 8, accounts are given of the miraculous feeding of the Israelites in the wilderness of Sin. In particular, these verses describe the fulfilment of the divine promise, “Behold, I will rain bread from heaven for you in the morning ye shall be filled with bread”¹. In the verses quoted we read, “And when the dew that lay was gone up, behold, upon the face of the wilderness a small round thing, small as the hoar frost on the ground. And the house of Israel called the name thereof Manna and it was like coriander seed, white, and the taste of it was like wafers made with honey.” Without going into serious critical questions bearing either on the length of the wilderness wandering or the number of individuals that the nation then comprised—both of which points are of particular importance in connection with this miracle—the first impulse of the scientific mind would be to collect data that are in any sense analogous to the facts recorded in Scripture, and institute a comparison. Thus, to cite two

¹ Ex xvi 4, 11

304 SPIRITUAL INTERPRETATION OF NATURE

or three data of this character (a) it is known that the tarfia tree (*Tamarix mannifera*, Ehr) when its twigs are punctured by a scale insect (*Gossyparia mannipara*) exudes a viscous substance which is collected in the desert by the Arabs and sold to pilgrims. Other trees have a similar property, and although the supply of such trees in that particular region is now insufficient for the supposed purpose, it is possible that formerly they may have existed in far greater numbers (b) A lichen (*Lecanora esculenta*) occurs on the desert limestones, showing similarity in several respects to the manna of Scripture. It is wind-borne and sometimes swept along in torrential rains, and is used as food in the steppe regions of S W Asia in years of famine (c) Preternatural rains of esculent lichen torn away by the winds, and borne to a distance, have occurred from time to time in Persia, "as at Oroomiah during a famine in 1829, and again at Herat while that place was being besieged"¹ The scientific mind will then weigh the Scriptural statements in the light of facts such as these. Prof A Macalister,² in considering the first suggestion, believes that these exudations are physiologically insufficient as food, and states that they keep indefinitely and cannot be cooked as was the manna, which therefore "was a miraculous substance." But it is conceivable that to others, considerations like those that can be advanced in connection with suggestions (b) and (c) may appeal, in which case the miracle would lie in the fact that under these particular conditions the Israelites were provided with food in accordance with the divine promise, and would be more akin to the old idea of a "special providence."

If in connection with the New Testament we turn to the Resurrection, it is only because than this no miracle is more central, more vital to Christianity. It might have been more fruitful to take a case like the stilling of the lake-storm, and see how far the analogy between the will of man acting upon the energy of Nature and producing results, and Christ's will acting as an extra-

¹ *Outlines of Geology* by James Geikie, p 10

² Art "Manna," Hastings' *Dictionary of the Bible*, vol iii p 236

ordinary power upon Nature, would carry us The electrical discharge of a submarine mine is ultimately the affecting of accumulated energy directly through the will the material elements are in a sense negligible Once we realise the fact of spiritual agency in the world, it will not be easy to set limitations to it, and in the action of the human will upon energy we have as yet a fact and an unsolved problem But though in the matter of the Resurrection, Science cannot help us with analogy, still, in her critical examination, we believe she can do real service The scientific study of hallucinations, for example, shows how totally absurd the hallucination theory of the Resurrection is¹ Hallucinations are usually preceded by conditions of excited expectancy, but the faith of the disciples suffered a total eclipse at the Cross—they had no expectancy of the Resurrection Distinctive hallucinations do not usually affect more than a single individual, and they are commonly confined to a single sense, but in the case of the witnesses to the Resurrection it was quite otherwise If, on the other hand, they affect a great number of people, like the supposed passage of Russian troops through England in 1914, they are short-lived, and produce an inevitable reaction Again, in the whole vexed question of the material resurrection of the body as distinct from spiritual immortality, Science will not improbably be heard² But, finally, Science will have to consider in this crucial case not merely the possibility but the probability of such a miracle here due weight will have to be given to the unique character of Christ, the whole purpose of His life, and the general congruity and naturalness in the association of this miracle with Him³ It is impossible for us to set limits to what a sinless Being

¹ W N Rice, *Christian Faith in an Age of Science*, p 369

² Sir W F Barrett, F R S, has somewhere hazarded the statement that enough is known mathematically of the conditions of four-dimensional space to enable us to realise that the post-resurrection appearances of Jesus Christ, e.g. the sudden appearance in the upper room, could quite well be explained on the supposition that during the forty days He moved in space of four dimensions

³ For further treatment of this point, see *Man and the Attainment of Immortality*, pp 299, 300

—one *i.e.* who was in perfect sympathy of feeling, thought and will, with the divine order of the universe—might be or do. And we cannot get away from the fact that the people of His generation were aware of something about Him—that which we express under the term “divine”—which they could only explain by the category of miracle, that His exercise of these powers—His whole use of Himself, so to speak—was contrary to their expectations of what He should do with Himself being what they recognised Him to be, and that, immediately after His public execution, the realisation of His divinity became the central certainty in the lives of numbers of men and women. Something at any rate happened which convinced them that He whom they had known in the flesh was still alive and had triumphed over death. Belief in the Resurrection, however susceptible to criticism the different accounts may be, must ever be easier than unbelief, for in this world as we know it, it is inconceivable that the greatest instrument for morality that history has ever known—the Church of Christ—should have been founded on a deception.

It would seem, then, that the attitude of Science to miracles must be of this nature. In the first place, to deny their possibility is to be untrue to herself. All *a priori* arguments against miracle are purely mental presumptions. Miracles are contradicted by no facts, the facts on which a law is based do not avail beyond these particular facts, nor does the law either, except by an act of faith. In the second place, with regard to recorded miracles, her attitude must be to consider them critically in their textual and actual setting and general congruity, and thirdly, to admit the possibility of phenomena as due to law that is not yet fully understood. How short is the passage from this position to the theist's conception of miracle as due to the more direct action of God intensively in and through the course of Nature as ordinarily known to us, may be briefly considered in conclusion. For to one who thinks of Nature as the orderly expression of the working of a divine indwelling Spirit which yet is not exhausted by the operation of natural forces, and is in that sense

transcendent, to one for whom the cosmic order is no rival of God, but rather the continuous manifestation of His sustaining and controlling activity, to whom therefore all events are physical in the mode of their occurrence but spiritual in their causation, it does not seem incredible that God should manifest Himself in ways of which we have no previous or modern experience. Whether the miracle be due to unknown combinations of known natural forces or to natural forces hitherto undetected, is of no great matter. What is urged is that to maintain that a miracle has not occurred because we do not understand the character of its causation, is to make the inadmissible assumption that all that we know is all that is possible—is, in short, to claim omniscience. Nor is it incredible that though God is ordinarily known to us in the order of Nature, which He has established as a worthy and permanent expression of His creative and sustaining will, yet should He also manifest Himself for special purposes in some unusual impulse. To deny this is to refuse to God the liberty He has given to man. Under the conception of spiritual law in the natural world the modern thinker finds no great difficulty in his theistic interpretation of the world-process—God is Spirit—nor hesitates in his thought of miracle as an express act of this indwelling yet transcendent Spirit, taking its place in the world order—“an outflash of psychic activity from the realm of eternal Reason not inharmonious with that activity which appears in the regimented phenomena of the world”¹. After all, the characteristic feature of a miracle is not its rarity or uniqueness, it is its clearer indication of the reality of a spiritual world, of the actuality of God’s presence in human life. This aspect, while no doubt always with its phenomenal side, will never vindicate itself so much in the character of a natural experience in time and space as in that of an experience of the living God Himself. The belief in miracle is the assertion of the religious mind that this world in which we find ourselves is God’s world, and that He is in it, that the process of which we are a part is a spiritual process and

¹ C. M. Tyler, *Bases of Religious Belief*, p. 238

that He is not bound. On that transcendental side its value will not lie in the circumstance that it can or cannot be fitted into that "hang" of things which constitutes Science. If the aversion to miracles is simply an expression of belief in a purely mechanical self-contained world, then the human spirit must hail them in defence of its own liberty. For if God be so bound by His laws that initiative is no longer His, much more are we. And if He cannot intervene in the physical realm, still less can He do so in the spiritual, for the two stand in close relationship. The miracle is the sign of the Divine freedom. Yet we may be sure that it is no detached or lawless event. whatever a miracle is, it is not an intrinsically unintelligible thing, a vagary, an ultimatum to Science. With God all rational things are possible, but none is miraculous to Him. The world must look very differently from God's point of view and from man's, and when ours shall have been changed in greater nearness to His, we shall not merely understand the ways of His workings. From what we know of the Divine character we may be sure that we shall realise more fully than we do now, not merely that "all's law," but that "all's love."

Ultimately then a miracle is any experience in which a man becomes directly aware in his own life of the actuality and activity of the living God. That is the core of the conception. That it is which makes Jesus Christ the supreme miracle. We read in the Old Testament story¹ of how Moses turned out of his way to see a bush that burned with fire, and was not consumed. It is difficult to know what Moses actually did see, difficult to suppose that if anybody else had been there he would have seen a bush burning and yet unconsumed. Perhaps as Moses wandered one day towards evening in the silence of that wilderness, pensive and brooding over the condition and destiny of his people, he may have raised his eyes from the ground so that they rested on some desert bush standing in the direct line of the setting sun, while above it were strikingly visible the waves of heated air rising from the overheated ground. That, however,

¹ Exodus iii 1-10

is not the miracle nor anything in that realm of explanation. The whole essence of the miracle is that Moses during these moments went through some experience in which he became absolutely sure of God, and as the result of which the whole character and trend of his life were completely changed. That this is the essential, though not necessarily the whole, account of what is involved in miracle, may even be seen from such a New Testament incident as the following. "Jesus said Father, glorify Thy name. There came, therefore, a voice out of heaven, saying, I have both glorified it, and will glorify it again. The multitude therefore, that stood by, and heard it, said that it had thundered. Others said, An angel hath spoken to Him. Jesus answered and said, This voice hath not come for My sake, but for your sakes. Now is the judgment of this world."¹ Without the awakened spiritual sensitivity, the "miraculous" event may mean no more than a natural phenomenon in time and space.²

Further, this attitude to the question of miracle furnishes us with the possibility of representing to ourselves why it is that miracles of some of the types recorded in Scripture do not occur to-day. For although in those earlier stages of human history there were always some souls with highly developed spiritual sensitivity, yet the evidence of Divine power was mainly apparent in the physical and concrete. At any rate, it was in that sphere that it was looked for. Spiritual appreciation even in our Lord's day was not in general so highly developed, as to be capable of appreciating evidence for divinity along purely spiritual lines. Since those days we have been given the revelation of God in the scientific understanding of Nature, although some of us tend to forget the rule which Professor Rendel Harris tells us he first learnt from his "dear friend, Frances Power Cobbe, that we must not cease to believe that God did anything because we have found out the

¹ John xii 28-31 (R V)

² Cf. from different points of view in this connection, Luke xvii 11-19, John ii 23-24, Matthew xiii 58, Mark vi 6

way in which He did it " ¹ If to-day a man anywhere saw a bush burning and not consumed, it would not produce any moral effect upon him, and it would be his bounden duty, as a man living in the twentieth century, to try and find out the cause of the phenomenon in terms of his knowledge of physics and chemistry. On the other hand, we are just beginning to appreciate the moral supremacy and significance of Jesus. We have little power to do so yet, as the scant moralisation of business life or the present world-crisis tends to show. The personal realisation of Him not merely as pattern, but as present power, is the miracle for every man who makes the discovery, and the more he knows himself, the greater a "wonder" will it become to him. We have no faith in miracle that could carry our faith in Jesus: it is He who carries our faith in miracle.

¹ *The Guiding Hand of God*, p. 53

CHAPTER XVII

EVOLUTION AND IMMORTALITY

THERE is probably a moment in the life of every individual when Job's persistent question in some form demands an answer, If a man die, shall he live again? ¹ As one looked on the field of the Khodinka disaster at the time of the Czar's coronation in 1896—"worse than anything I saw at Plevna," as the *Times* correspondent remarked—and saw the old human hulks being jogged off on the top of fire-brigade waggons and other unusual impressed vehicles, the question inevitably rose in one's mind, "Is that the end of the story?" Sometimes the individual may feel very certain about the answer, at other times he has greater difficulty, and looks around for every aid in the hours when the immortal hope burns low. Science has helped much in other matters, and some have looked for her assistance here, but to the problem she makes no direct contribution, it is difficult to see how she could. At the same time, she throws certain sidelights on the question that do help just a little in its illumination.

She may illuminate the dark sayings of the objector. It is perhaps permissible to maintain that some of the objections to the possibility of immortality have no more profound origin than sheer lack of imagination. To the crude secretion view of Cabanis on the relation of thought to the brain, William James ² replied in effect, "There are other possible relations than that of production," and then, in particular, starting from the idealistic position that the whole universe of material things is but a surface veil of phenomena, he showed how the facts, so far as they are known, would be

¹ Job xiv 14

² *Human Immortality*, p 30 et seq

equally well, if not better, expressed by the conception of our brains as prisms, through which streamed rays of the divine light—rays, however, that are strangely distorted and dimmed by reason of the too constant opaqueness and coarseness of the conducting instruments, our idiosyncratic selves—or as thin and semi-transparent places in the veil, through which are diffused into this world suggestions of the true life of souls in all its fullness. Which is particularly interesting when we recollect those cases, by no means confined to sacred records, where just previous to death, the veil has become preternaturally thin, the prism unwontedly translucent, and the “heavenlies” have broken in on the individual’s consciousness ere he has joined himself to them.

Again, the idea of a spiritual body almost seems a contradiction in terms, yet modern conceptions of matter make views of an ethereal body or soul eminently intelligible. “Thou sowest *not* the body that shall be”,¹ and the whole conception of a resurrection of the body is but a Pharisaic skin in which the new wine of the revelation of an endless life was first conveyed to men. Physical science can offer to the imagination lines of thought along which the soul or its ethereal counterpart are at least intellectually separable from the grosser material in which it is obliged to accommodate itself here, in order to hold intercourse with other souls, and come into relation with the material world. That we have no experimental evidence of such an ethereal soul is nothing to the point, so far as the suggestion is made to combat the view that the physical dissociation of the elements of the body is the final stage of a human life-history, and on the contrary, there are quite sound reasons why such evidence could not be available.

In short, it is simple dogmatism that would deny immortality on scientific grounds, at any rate, we have not the knowledge to take up such an attitude. Indeed, when we consider how the potentiality of an adult human organism, brain and all, lies at its primal moment in a speck of matter of microscopic size (0.2 mm), the

¹ 1 Cor xv 37

difficulty of conceiving some continued relationship between that fully developed consciousness and a minimum of matter, supposing that to be necessary, is not so very great. Across this infinitesimal vital viaduct passes the condensed experience of millions of individuals, showing us that the spirit may safely be given into the keeping of other forms of matter than the brain affords. Hence it is not improbable that matter in certain forms far simpler than the nervous system may bear the germs of high intelligence. What we do know of the slightness of the connection of the personal life with matter at its birth, almost justifies us scientifically in affirming that the dissolution of a body is not necessarily the destruction of all relations of the individual to the outward universe. The viaduct for the fairway of the soul both at birth and at death may be laid from the foundations of the world, although it may not in either case be visible to our senses. At any rate, our ignorance of matter and its relation to spiritual activity is so profound that the fact of a capacity for death cannot be made the basis for an induction as to the non-survival of intelligence. In days when the physicist asks us to believe that the mass of the electron varies with its velocity, and a biologist assures us that it is "the poverty of our language, or rather the legacy of a materialistic age, that compels us to speak of particles that move, rather than of motions as entities in themselves,"¹ it should not be so difficult to envisage the idea of consciousness as apart at any rate from gross matter, while the philosopher insists, in opposition to "substantial" views of the soul that the "coherent unity of experience is the self, mind, or soul, in the only intelligible sense of these words."²

On the positive side we are unaided by science towards an absolute demonstration. At the same time, there are many suggestive things—"Intimations." Wordsworth was bold enough to call them—that help us in our trust. They are of very different value, but their cumulative effect is not inconsiderable. One of

¹ Prof. J. Johnstone, *The Philosophy of Biology*, p. 356

² Prof. A. S. Pringle-Pattison, *The Idea of Immortality*, p. 100

these is the existence of what have been called critical points or crises in the economy of Nature¹ A not unnatural deduction from the doctrine of the conservation of energy, due to preoccupation with its modes of transformation 'and the routine of antecedent and consequent, leads men to imagine that there is a definite uniformity of quality of action in Nature But is it so? Consider the story of a crystal of ice It is definitely recognisable as such with its characteristic qualities, and these it would retain under certain conditions indefinitely But subject it to heat, make some slight change in its environment, and at a certain point it no longer conforms to the old environment, but has been transformed into something else—water With regard to this transformation two things in particular are noticeable In the first place, the change with its results and the vastly different qualities of the new substance could not have been predicted from any study of the ice crystal as such, in the second place, the difference in the environment, the change in the temperature required to bring about this transformation, is immeasurably small We say 32° Fahr is the point, but it is, so to speak, something much smaller, done in something less than the span of a degree of temperature Follow the process further Increase the heat, and again at a certain point a wonderful transformation takes place The drop of water is no longer there, it has disappeared, but it is not lost And all our study of the water-drop as such would never have led us to imagine that with this immeasurably small change of temperature it would have been so transformed Such transformations in Nature are by no means the exception The suggestion is, that death, perhaps, is just such a critical point, when there is a change to something in an entirely new realm, of which we can form no conception from our study of the living body The difference in temperature of water as ice or fluid and as fluid or vapour is extremely small, and yet how great is the effect of this difference! Each is a point at which origination of quality is in some way developed

¹ N S Shaler, *The Individual*, p 292

A further consideration springing out of the relationship of man to his environment has been urged with great force by Fiske¹ If man is indeed but a physical being, why is he, unlike all other creatures, not satisfied with proper physical conditions? What has he to do with a spiritual environment at all? If all values to him perish with the body, what is the meaning of his instincts and affinities for the spiritual, the infinite, the perfect, the permanent? He does not find his satisfaction, his true life, in ends that centre in his body as a rule—there are exceptions, but we do not call them men. Is not history replete with tales of those who, for the sake of realising their nobler life, have sacrificed their bodies in devotion to truth and justice? Perhaps, it is objected, the instinct was misguided and corresponds to fancy only—to nothing, *i.e.*, external to him. But is it not strange that God should have so constituted man that he feels himself to be truly living only so far as he seeks the spiritual, the perfect, the permanent, if there is naught in his environment and destiny corresponding to such a nature? It is not merely strange, but anomalous, in the world as we know it. For every advance and every feature of man's life has been evolved in response to something external to him. The eye has been developed in response to ethereal undulations, the ear in reply to the impact of the waves of sound, maternal love has been elicited by a little child, and every virtue we possess has been developed under the stimulus of something noble but originally external to us. And does this spiritual sense—this within us that is felt to be greater than all that is around us—alone correspond to nothing real and external to us? That the human spirit should be united with a physical body for a time for character formation and all higher education—even for mere purposes of communication in a physical sphere—is not perhaps unintelligible. But that this spiritual nature, whose scope and outlook is the Infinite, should vanish with the body, corresponding to nothing externally, is contrary to the whole cosmic economy, and would constitute the sole irrationality in the universe as we

¹ John Fiske, *Through Nature to God*, chap. x

316 SPIRITUAL INTERPRETATION OF NATURE

know it. Rather are we compelled to think of ourselves as finely minted coin, and to every characteristic mark and feature do we feel certain that something corresponds in the die in whose image we are created. In many the image is defaced somewhat in the hard usage of life, but we can well imagine the divine Artificer making the sole test depend on whether in the end the individual coin rings true, in which case it is gold and will not perish, standing the fire.

Possibly the most effective considerations are those derived from the rationality of the universe taken in conjunction with the teachings of evolution. Evolution has entirely changed our conception of man. Time was when he was considered as absolutely distinct from, and having no relation in origin with, the brute creation around him. He was placed on a pinnacle by himself, and all accounts of the universe began with him, and explained everything from him, they were worked out from above downwards. The modern story leads up to man through the rest of the creation—it displays his kinship with the lower creatures, but also emphasises that wherein he is alien to them. It shows that not 6000 years but mayhap 600,000 years ago man arrived, and tells of ages of previous life that were not altogether unconnected with him. In man Science sees the goal of creation—she assures us that there will never be a creature higher than man, she recognises in him the consummation of the whole. And these two views differ in dignity, truth, and service as do the Ptolemaic and Copernican theories of the motions of the heavenly bodies. But from the side of pure materialism we are invited to believe that this age-long process has been set in motion to produce man, and that at death its fairest blossom is merely thrown out into the night. We are shown a long line of ancestry whose beginning is lost in the seemingly interminable past—groups of creatures crossing the stage of existence, playing their little rôle, and for the most part disappearing or giving rise to other forms. We are shown a series unbroken yet sharply marked by values of increasing worth, till at the end comes man—most truly man when dominated

by love and conscience. He has closed the series because he has revealed its final cause in himself, so that we are fain to say that in order to produce man it was necessary to evolve the tenuous but persistent line of life from Cambrian days until this present. In face of the thousands of progressive distinct modifications that led up to the estate of man, what were the chances of such a process working out correctly if it were not guided, if there had not been this end in view? They are infinity to one. So that, as we look down the long vista, we refuse to believe that in man's case death ends all. To do so is to rob not only existence, but the process, of its meaning. Man is the outcome of the travail of a universe, and it were strange if there is no potentiality or value associated with him exceeding the cost of his extraction. Is it conceivable, then, that this age-long process is to break down at the last stage? "A good play," said the Absolute, "let us have it over again!" Unless life is some gigantic anticlimax, and the world-process totally devoid of significance for its masterpiece, it cannot well be so. What is unreasonable in supposing that just as man's body has nearly reached the goal of terrestrial development, so his spirit may just be commencing a corresponding career that shall be continued hereafter? Rather, therefore, do we hold that the final goal, the only reasonable conclusion of that world process whose aim is the continued perfection of adaptation to environment, is the begetting of souls faultlessly adapted to the spiritual world, the moulding of beings whose life has acquired that selective value upon which the forces of the world to come can fasten, and will therefore possess survival value beyond the environmental change of death. That is to say, there may well be human discontinuous variations in the direction of "an endless life," and death be for them no more than a "break."

Further, with the possibility, nay the probability of continuity admitted, speculation has sometimes busied itself with philosophical inquiry into the nature of the change, with the question whether it is undergone by all men, whether there may not be some winnowing process going on even now, whereby, although in every

318 SPIRITUAL INTERPRETATION OF NATURE

man there is the possibility of survival, yet it may not become a reality. Again the question rises, what is it that persists? In an evolutionary process that has tended towards higher and higher individuation we have to try and find out wherein this individuality consists. We have realised the dividuality of humbler forms¹ and are aware of a certain permanence beneath the outward changes that constitute the life-history of higher forms, until in the case of man the significance of individuality becomes so great, and its effects so strangely persistent, that it looks as if we had not yet learned to appreciate it in its fulness, and perhaps have not all of us attained it in its supreme form. This failure to appreciate individuality is illustrated by Professor Royce in a passage of singular beauty,² in which he takes as example that individuality which every man is perfectly certain he can describe—namely, that of the woman whom he loves. And yet, he maintains, when you examine and analyse the descriptions of a dozen lovers, you find that they are all saying pretty much the same thing, although necessarily and fortunately about different individuals, are in fact, each of them with the beatific vision before his eyes, yet only describing a type—the perfect woman—and utterly failing to convey anything to you by which you can lay hold of the individuality of that particular one whom he loves. “So careful of the type he seems—so careless of the single life,” which is “an insult to loyal love,” but at the same time an expression of a lack of achievement, so suggesting that perhaps we attain to immortality what time this human bundle of sensations, feelings, and aspirations shall have acquired *Individuality* and wholeness, what time it shall have attained to that degree of unified self-conscious moral personality, through coming into new and eternal relationships both with the universe it inhabits and with the Supreme Personality in that universe, that, as a consequence, it cannot possibly be holden of death.

¹ P 79, for a fuller treatment of the subject-matter of this chapter, reference may be made to *Man and the Attainment of Immortality*

² *The Conception of Immortality*, p 64

Considerations of this nature, together with the whole method of Evolution, seem to point in the direction of the theological doctrine of Conditional Immortality. Now it was Plato, not Jesus Christ, who taught that the soul is inherently immortal, and the further fact remains that if we exclude the Platonic myth, there is no conception of immortality in or out of Scripture that is not in some vital sense conditional. Accordingly, if it appear that immortality is a moral achievement, conditioned in part by our own efforts, in part by our alliance with God, there is nothing in Scripture to challenge the contention "Good Teacher, what shall I do that I may inherit eternal life?" asked one of Jesus,¹ and the Teacher did not at any rate correct his view of immortality as an attainment. On the contrary, His teaching on this hope is comprehended in the categories of life and death.² "The Gospels are biological altogether."³ Jesus Christ placed before men the conditions of "immortality." He showed the way of eternal life, with its adaptation to its particular environment, which is God. Nor did the earliest Christian writers understand His teaching on this matter in any other sense. Nowhere in their writings is a hint to be found of a belief in the natural immortality of the soul, their declarations follow the typical conception of their Teacher. They represent the attainment of the conditions in question as something to be striven after.⁴

What, then, is the nature of this achievement of immortality? Essentially the condition is moral. The precise moment is often not easier to indicate in the individual life than that at which self-consciousness has dawned. We have seen the tremendous range of mental achievement within the human race, and the range of moral achievement is not less. In self-consciousness is revealed the ordinary climax of the individualising process, the individual becomes aware of the possibility of its individuality. Even on the purely physical side, the fact that the prodigality of life is increasingly checked

¹ Mark x 17

² John iii 16, v 24, Matt vii. 13, 14, etc

³ S. D. McConnell *The Evolution of Immortality*, p 110

⁴ Phil iii 11, Heb x 39 (R V marg)

as it progresses, until in man it affects both the period of reproductive power and the number of offspring, suggests an increasing value. But humanity includes many units that are not men, in the highest connotation of the term. Until a man appreciates not merely the abstract distinctions between good and evil, but also the practical personal responsibility in right and wrong doing—its present determining influence—he cannot understand the implications of this present life, the possibilities of a higher life, the conditions of the attainment of immortality. To the man who has never known or experienced anything in his life for which he is willing to die, Immortality must ever be a chimera. On the other hand, the more intense and rich the life of the spirit—the more adapted it is in any specific case to the true environment of souls—the more does the thought of extinction become impossible, the more certain is the conviction, even the present awareness, of immortality. To be “united with Christ” represents a spiritually and morally tempered condition of prepotency whose survival of death is natural. It represents a moral achievement that was likewise open to those who in spirit saw His day afar off and were glad.

The older Scripture writers reached their belief in immortality as the result of experiences that we can share with them. Communion with God was to them something so real, so great, so necessary, so satisfying—a man’s moral relation to God so absolutely constituted the bond of the diverse elements in his nature, *i. e.* his individuality—that the mere thought of the interruption of this fellowship by death elicited a protest, “Thou wilt not leave my soul to Sheol, neither wilt Thou suffer Thine Holy One to see corruption.”¹ Fellowship with God would last through death—the believer demanded that he should overleap Sheol and pass to God—“But God will redeem my soul from the power of Sheol, for He shall receive me.”² And Jesus had the same intense conviction. “My Father, which hath given them unto Me, is greater than all, and no one is able to snatch them out of the Father’s hand.”³

¹ Ps xvi 10² Ps xlix 15³ John x 29

Jesus was inexpressibly certain of Immortality just because His earthly life was inexpressibly perfect and beautiful, and in complete harmony with God. Therefore it is that we can understand that it was not possible that He should be holden of death—that it was, in short, natural that He should be “alive for evermore”¹ Therefore it is that we believe Him as we hear Him say majestically, “I am the Resurrection and the Life he that believeth on Me, though he die, yet shall he live and whosoever liveth and believeth on Me shall never die”²

¹ Rev 1 18

² John xi 25, 26

GLOSSARY

- ALLELOMORPHS** —Contrasting or alternative unit characters, now often applied to the genes, similarly situated on homologous chromosomes, which correspond to them
- AMPHIOXUS** —One of the lowest and simplest animals having a notochord (backbone)
- ANTIBODY** —A specific chemical substance in the blood which produces immunity to pathogenic bacteria
- ASCARIS** —A genus of round worms which are intestinal parasites
- ASCIDIANS** —Also known as Tunicates, an interesting sedentary, but degenerate, marine group The larval form is free-swimming and chordate
- ASTER** —The radiating figure surrounding the centrosome during cell division
- BINARY FISSION** —The division of a unicellular organism into two daughter cells
- BLASTOMERE** —Single cell of blastula
- BLASTULA** —A stage in development formed by repeated divisions (cleavage) of the egg, when the cells are arranged in a single layer to form a hollow sphere
- CATALYSIS** —The acceleration of a chemical reaction by a substance which itself remains unchanged throughout the process
- CELLULOSE** —A carbohydrate which is the characteristic component of the plant cell-wall
- CENTROSOME** —The minute body at the centre of the radiations in a dividing cell, dynamic in function
- CHROMATIN** —The deeply-staining granular substance characteristic of the nucleus, which is the main component of the chromosomes
- CHROMOSOMES** —The deeply-staining bodies found in the nucleus during mitosis (indirect division)
- CILIA** —Minute hair-like protoplasmic projections from the surface of certain cells, whose co-ordinated movement effects the progression of the cell
- CILIATA** —A large group of the Protozoa (Infusoria) characterized by definite form and locomotor cilia, *e g* *Paramecium*, *Stentor*, etc
- CœLENTERATA** —A group including jellyfish, sea-anemones, and corals, distinguished by their two-layered body with a single internal cavity

324 SPIRITUAL INTERPRETATION OF NATURE

- COLLOID**—A state of matter in which a substance is finely divided into particles larger than a single molecule and suspended in another substance
- CONJUGATE**—One of a pair of protozoon cells which unite
- CORTEX**—The thin sheet of grey matter overlying the core of nerve fibres that forms the greater part of the mass of the cerebral hemispheres
- CYTOPLASM**—The protoplasm of a cell outside the nucleus
- DETERMINER**—The differential cause or factor in a germ cell which determines the development of a character
- ECHINODERMATA**—A phylum of marine invertebrates which includes starfishes and sea-urchins
- ECTODERM**—The outer layer of cells of an embryo, *e.g.* at the gastrula stage. It gives rise later to the epidermis, sense organs and nervous system. Sometimes called Epiblast
- ECTOPLASM**—Modified outer layer of cytoplasm of a cell
- ENDODERM**—The inner layer of cells of an embryo, which later gives rise to the digestive cells of the alimentary system. Sometimes called Hypoblast
- ENDOMIXIS**—A process of nuclear reorganisation observed in some Protozoa, *e.g.* *Paramœcium*, which does not involve the union of nuclei from two different cells as in conjugation
- ENZYMES**—Complex chemical substances formed by organisms, which bring about by catalytic action many of the chemical processes of the body
- EPIBLAST**—See Ectoderm
- EPIGENESIS**—The doctrine of development from a relatively simple and homogeneous germ with the differential causes held to be resident in the environment
- EPITHELIUM**—A layer of cells covering an external or internal surface
- FACTOR**—A specific germinal cause of a developed character.
- FERTILISATION**—The union of male and female gametes or sex cells
- FLAGELLUM**—A whip-like, vibratile prolongation of the cytoplasm, which functions as an organ of locomotion
- FLUCTUATIONS**—Relatively slight variations
- GAMETE**—A cell which unites with another at fertilisation to form a zygote, an egg (ovum) or sperm (spermatozoon)
- GANGLION**—A group of nerve cells
- GASTRULA**—A stage in animal development, succeeding the blastula, where the body form consists of a two-layered sac—ectoderm and endoderm—enclosing the enteric cavity which opens to the exterior by the blastopore
- GENES**—Factors, units, or elements in the chromosomes of germ cells, which condition the characters of developed organisms
- GERM PLASM**—The physical basis of inheritance, the chromatin
- HOMOLOGOUS CHROMOSOMES**—The members of a pair of chromosomes, one paternal and the other maternal in origin, which bear the same or allelomorphic genes

- HORMONE** —An internal secretion, usually from a ductless gland, which is distributed by the blood and influences the activities of one or more parts of the body
- HYPOBLAST** —See Endoderm
- IRRITABILITY** —The power of responding to stimuli as shown by protoplasm
- LININ** —The material of the nuclear framework, upon and throughout which the chromatin appears to be distributed in the resting cell
- LINKAGE** —The inheritance of characters in groups, probably occasioned by the close association of the corresponding genes on the same chromosome
- MESODERM** —A layer of embryonic cells lying between the ectoderm and endoderm
- METABOLISM** —The transformation of matter and energy within a living organism
- METAPHYTA** —Multicellular plants
- METAZOA** —Multicellular animals
- MITOSIS** —Process of indirect nuclear division
- MODIFICATIONS** —Changes in the body or soma due to environmental influence acquired characters
- MUTATIONS** —A marked heritable variation due to a definite change in the constitution of the germ plasma a sport, or organ
- NUCLEUS** —A specialised protoplasmic element in every cell, characterised by the presence of chromatin
- ONTOGENY** —The developmental history of the individual Cf Phylogeny
- ORTHOGENESIS** —The doctrine that the course of evolution is definitely directed by intrinsic causes
- OSMOSIS** —The principle of diffusion of dissolved substances through a semi-permeable membrane
- PARTHENOGENESIS** —The development of an egg without fertilisation
- PHYLOGENY** —The ancestral history or evolution of the race Cf Ontogeny
- PRIMATES** —The highest order of mammals, including monkeys, apes, and man
- PROTEIN** —A complex organic substance, containing nitrogen, which forms the chief characteristic constituent of protoplasm
- RECESSIVE CHARACTER** —One of a pair of alternative characters which remains undeveloped when mated with a dominant character
- REDUCTION DIVISION** —The maturation division during which the chromosome number is reduced by one half
- SEGREGATION** —The distribution of contrasting genes (allelomorphs) to separate gametes during the maturation of the germ cells
- SEX-LIMITED** —A character the determiner of which is associated with the determiner of sex (the accessory chromosome).

326 SPIRITUAL INTERPRETATION OF NATURE

SYNOPSIS —The conjugation of maternal and paternal chromosomes preceding the maturation divisions

TROPISM —Automatic movement of an organism as a whole toward or away from a source of stimulus

UNIT CHARACTER —A character which is inherited as a whole and cannot be sub-divided

ZYGOTE —The composite cell formed by the union of male and female gametes (sex cells)

INDEX

- Abiogenesis 109
 Abstract character of Science, 13 23
 Accessory chromosome, 87, 89
 Accretion, growth by, 72
 Acquired characters, 144 ff, 157, 169 ff
 Adaptability a characteristic of life 67, 136 225
 Æsthetic implications of Nature, 22
 Allelomorphs, 174, 175
 Altmann's units 63
 Altruism, 117, 195, a factor in Evolution, 137 ff 195
Amphioxus, 97, 98, 99
 Ancestral inheritance, Galton's law of, 161
 Aquinas, St Thomas, and Creation, 237 238
 Arnold Matthew, 1
Ascaris 64, 100
 Assimilation, 73
 Astronomy and purpose, 215
 Attraction-sphere, 59 64
 Augustine St and Creation, 236, 237 245, on Sin 284
 Authority, place of, in religion 34
 Autolysis, 51
 Avebury, Lord, 14

 Barrett Sir W F, 244, 305 n
 Bascom, J, 8 n, 120
 Bateson, W, 149, 177, 179, 195, 244
 Behaviour, 252 ff
 Belief, 41, 42
 Beneden, van, 64
 Bergson H, 23, 265 ff, 275
 Bernard H M, 57, 60, 61, 62, 67, 204
 Bettex, Professor, 16
 Bicknell, E J, 239 n

 Biogenesis 109
 Biological unit 60 ff
 Biology principles of, chaps III and IV
 Birth-rate, decline in 183
 Bishop of Ripon, 183
 Blastomeres, 93 97
 Blueness of the sky, its cause, 10
 Bonnet and Wesley, 242 n
 Boutroux E, 18, 28
 Boveri 88, 89 100
 Bowne, Borden P, 226, 249
 Boyle's Law 299
 Breaks in the succession, 108 ff, 260, 317
 Brown, R and cell nucleus, 58
 Bumpus H C, observations on sparrow, 147
 Burbank L, 151
 Butler Samuel, 172
 Bütschli 48 n

 Catalysis 72 n
 Causation law of, 25, conception of, 217
 Cell structure of 56 ff, theory of 57, unity of, 65, nucleus 59, wall 64, 74, division of 82 83
 Centrosome, structure and function of 64 ff
 Centrosphere 64
 Certainty sphere of, 18
 Chance 218
 Change in organism, 49, characteristic of Evolution, 104 ff
 Chapman, C, 109
 Chatterton-Hill G, 191, 192
 Chemical interpretation of life, 49, its insufficiency, 47, equation for life, 72
 Chloroplasts nature and function of, 10, 73

328 SPIRITUAL INTERPRETATION OF NATURE

- Chromatin, nature of, 60 ff
 Chromidial unit, 61 ff
 Chromosomes, nature of, 60,
 splitting of, 82, 88, reduction
 of 87, individuality of, 88,
 and heredity 60, 174
 Cleavage divisions of developing
 egg, 93 ff
Coccidium schubergi, 85
 Coelenterata, 57, 131, 254
 Colloidal nature of Protoplasm,
 46, of enzymes 75
 Colony formation in life, 57, 204
 Comparative Religion, 33
 Conditional immortality 319 ff
 Conformity to environment, 136
 Conjugation of Protozoa, 83, 91
 Conklin, E. G., 90, 91, 118, 177,
 178, 186, 198
 Conn H. W., 126, 129, 146
 Conscience natural history of,
 33 277
 Consciousness 206, 257, evolu-
 tion of 266 ff
 Conservation of energy 29
 Continuity in evolution, 108
 Convergence in Evolution, 225
 Correlation, 146, 147
 Coulter, J. M., 35
 Creation, 112 156, and volition
 217, chap. XII by Evolu-
 tion, 243 ff
 Creation Narratives 123, 232 ff
 290
 Creed of science, 39
 Criminal strains 186 ff
 Critical points in Nature, 110, 314
 Criticism value of Biblical, 34
 Cross-sterility, 123
 Crucifixion, 141
 Crystal growth of 72
 Cunningham J. T. 171
 Cytoplasm, 58, role of 96
 Czapek, F., 51

 Darwin, C., 21, 63, 106, 119, 121,
 122, 125, 126 150, 169, 175,
 178 201 251, 271, 273
 Darwinism, not synonymous with
 Evolution, 106, 152, 175
 Davenport, C. B., 166, 180, 186 n
 Davidson, Professor A. B., 234 n
 Dean, Bashford, on orthogenesis,
 223
 Death, capacity for 79, place of,
 in Evolution, 80
 Decline in birth-rate, 183
 Definition of science 12
 Degeneration, 116
 Dendy, A. 77 n, 123 n, 128, 173
Denialium, 98, 99
 Determinants 167
 Determinate variation, 148 ff
 Determinism, 198
 Development character of 96,
 Weismann's theory of, 97,
 166 ff
 Differences between plants and
 animals, 77 ff
 Differentiation of tissues, 85
 Dimorphism, 145
 Directive factor in Evolution, 119
 148, chap. XI
 Discontent an element in pro-
 gress, 135
 Discontinuous variation, 144, 149 ff
 Division characteristic of the cell,
 79, 82 83, 166
 Dominant Mendelian, 174
 Doncaster L., 162
 Draper J. W., 31 n
 Drelincourt on sex 166
 Driesch H., 51, 97, 100
Drosophila, 90, 153
 Drummond H., 137 271, 283
 Dugdale R. A., 136 ff
 Dynamic centre of cell, 64

 Education and susceptibility to
 pain, 133
 Edwards, Jonathan, family statis-
 tics 188
 Electricity positive and negative,
 17, 243
 Electron, 244
 Embryology problems of, 96 ff,
 and the recapitulation theory,
 125
 Endomixis, 84, 92
 Ends, recognition of, 22, realm
 of 107
 Energy, conservation of, 29,
 relation of life to, 53 ff
 Engram 172
 Environment, relation of organ-
 ism to, 80, 81 100, 117, 164,
 217 chap. X, relation to
 variation, 156

- Enzymes, problem of, 66, nature of, 74 ff
 Epigenesis 103
 Estabrook, on the "Jukes" 187
 Ethical aspects of struggle for existence, 129 ff
 Eugenics 22 192 ff 207
 Evil, Evolution and chap xv, physical evil, 280, 281
 Evolution, early conceptions of 96, chap v *passim*, proofs of 123, and creation, 243 ff, and mind 251 ff, and morality 271 ff, and evil 280 ff, and immortality, 311 ff
 Existence; joy of, 41
 Experience, unity of, 2, science and 22
 Experiment, value of, 36
 Experimental religion, 36
 Factors in Evolution, 117
 Facts basis of science 11 ff, 22
 Faith development of, 25 ff, genesis of, 25, place of, in life, 20
 Fall the, 31, 287 ff
 Family life as an integrating factor in social evolution, 191
 Feeble-mindedness 185
 Fertilisation 78 80 83 ff
 Fertility of varieties, 123
 Fiske John on Immortality, 315
 Food of plants and animals contrasted, 77 ff
 Fortuity, absence of in evolution 119, 143, 224
 Functional activity of organism, 51, inertia, 69, 70
 Galton Sir F, 151 161, 163, 179
 Gastrula, 254
 Geddes, P, 137
 Generalisations of science probable only 18
 Genetic variations, 144 ff, 168, 196
 Geographical proofs of Evolution, 123
 Germ cells, 85 166
 Germ plasm, 85 194
 God, conception of, 209, 243 ff, as Infinite Energy, 244, 269
 Gotch, Professor 52
 Growth of organism, 71, of crystal, 72, formula for 72, 80, cycle of 78
 Habit 70, 173
 Haldane Prof J S 50 51
 Harris, D F, 69, 70
 Harvey, 89
 Hearing limitations of sense of, 15
 Hearnshaw, Professor 110, 111
 Heredity theories of, 60, 63, associated with the chromosomes, 60, 90, chap viii, Weismann's theory of, 166 ff, mnemonic theory of, 172 ff, Mendel's theory of, 173 ff, and responsibility, 197
 Herrmann W, 3
 Hibbert, W, 55
 Historical method 32, proofs of Evolution 123
 Hoffmann F S, 13, 20
 Hormones, 171
 Hunzinger, A W, on Miracle, 298
 Hutton R H 33
 Huxley, T H, 25, 130, 238
 Hybrids heredity of, 173
 Ideals, origin of 27, 28
 Inheritance of emotional traits, 180
 Immanence of God 120, 247
 Immortality, personal, 42 chap xvii, of Protozoa 79 80
 Immutability of species 123, 124
 Incompleteness of Science 28 29
 Indifference of Nature 114
 Individuality not predicable of Protozoa, 79, of organisms in general 80, evolution of, 81, of chromosomes 88
 Inertia of living matter, 69 70
 Influence of Science upon Religion, chap ii
 Insanity, increase of, 185
 Instinct, 263 ff, 272
 Insufficiency of chemical interpretation of life, 47
 Intelligibility of the universe 219 ff

330 SPIRITUAL INTERPRETATION OF NATURE

- Interstitial growth, 72
 Intracellular units, 63, 64
 Irritability, 61, 66 ff, 252
 Isolation, 117

 James, William, 311
 Jennings, H S, 68, 253, 257
 Jeremias A, 233 n
 Jesus and Nature, 8, and suffering 141, and miracle, 302 ff
 Jevons, W S, 18
 Johannsen, 151
 Johnstone, J, 313
 Jordan, D S, 105 113, 158, 165
 "Jukes, The," 186 ff

 Kant, 18, 104
 Kapteyn, 213
 Keller, Helen 14 n 16
 Knowledge, unity of, 2, criteria of 10, nature of, 20
 Korschinsky 223
 Kropotkin, Prince, 137

 Lamarckian principles 25, factors 128 169 201
 Lankester, Sir E Ray, 2, 30 124 224
 Laws of Nature, 19 ff, 110 ff 217, of growth 73 80
 Learning as elimination of useless responses, 259
 Leduc, S, 48 n
 Life, characteristics of 45 ff, of seeds, 45, and matter 53, units of 60 ff, history 32, 78 ff
 Limitations of science 15, 21
 Linn nature of 60
 Linnæus, definition of species, 239
 Lodge, Sir O 29, 280, 299 n
 Loeb, J, 67 253
 Logion of Jesus 43
 Lull, R S, 123 n

 MacBride E, W, 47
 McConnell S D, on Immortality, 319
 MacFadyen, Prof, 301
 Macfarlane J M, 54 n
 Maeterlinck 40
 Maleness and femaleness, 86
 Malthus, 125

 Man and Mendelism, 176
 Mast, S O 254
 Mathematical certainty, 12, 19
 Matter, relation of life to, 53 244, 313
 Maturation, 87
 Maxwell Clerk, 243
 Mechanical interpretation of life, its insufficiency, 49 ff, 101, 102, 117 ff
 Mendelism, 90, 163, 173 ff
 Mental characters, inheritance of, 179 ff
 Mental Evolution, chap XIII
 Meredith, G, 41
 Metabolism, 71 ff
 Metaphyta 77
 Metazoa 77, 171
 Method, scientific, 32
 Milnes Marshall 125
 Minchin E A 61 89
 Mind, evolution of, chap XIII, relation of, to matter, 269
 Miracle, 113 127, chap XVI, possibility of, 296, interpretation of 306
 Mivart, St G 13 n, 38, 242 n
 Mnemic theory of heredity, 172 ff
 Modifications 144 169
 Molecular vibration 16
 Moore, Aubrey 239
 Moore, B, 53 54 n 74 n, 76
 Moral aspects of science, 7
 Moral characters, inheritance of, 180
 Moral evil 281 ff
 Moral law, 112
 Morality, Evolution and, chap XIV, and natural selection, 274
 More, L T, 23
 Morgan, T H, 90, 98, 153, 155
 Morphology, 58, 71
 Moulton, R G, 233 n
 Mozley, 22
 Mutations, 109, 149 ff

 Natural and Supernatural, 119, 248
 Natural selection, 92 106 117, chap VI, 144, 146, 147, 148, 149 150 153, 163, 182, 194 268, and morality, 274 ff
 Naturalism 295

- Nature, æsthetic implications of, 22, laws of, 110 217, religious contemplation of, 9, moral significance of, 7, philosophy of 5 117
 Necessitarianism, 118
 Nervous system comparative study of, 131 ff, 254 ff
 Newman, 17 n
 Nothing, creation out of, 156
 Nucleolus, structure and function of, 63
 Nucleus of cell, 58 ff, minute structure of, 59, nuclear membrane, 59, nuclear reticulum, 59, nuclear sap, 63, its part in reproduction, 87 ff

Oenothera lamarckiana, 151, 153
 Oersted 12
 Ontogeny, 51, 58, 173, 217, 223
 Order in Nature 221 ff
 Organic unity of the body, 65, Organic Evolution, 106
 Organisation, a characteristic of life, 47
 Organism and environment, 30, 81, 217
 Origin of life, 56, of species, 124, 154 ff
 Origins and Science, 22
 Original Sin doctrine of, 283 ff
 Orthogenesis 222
 Osborn, H F, 119, 224
 Over-Belief, 41, 42

 Pain, capacity for, 132, 281
 Palæontology, 58, bearings on causation of Evolution, 149, 224
 Paley, 35 106, 215
Pandorina 84
 Pangenesis 106, 128
 Panmixia 128
 Pantheism and panentheism, 246
 Parable of rose and lily, 105
Paramæcium, reactions of, 66, 72, 208, reproduction of, 79, 85, 92
 Parker, G H 131, 254, 255
 Parthenogenesis, 80, 92, 143
 Paul St., 4 n, 13, 17, 112, 211, 291 n
 Pearson, Karl, 161, 162, 179, 183
 Perfection 136
 Personality, 227, 247
 Peyton W W, 140
 Philosophy of Nature 5 117 ff
 Physiology, 58 85, 123, 131
 Pinsent Mrs 188
 Plants and animals distinguished, 77 ff
 Poulton, Professor E B, 124 n, 239
 Preformation 96 100, 103
 Primitive function of limb, 63 67
 Pringle-Pattison, Prof A S, 313
 Probable, sphere of the, 18-20
 Progress in Evolution, 116
 Proofs of Evolution, 123
 Proton, 244
 Protoplasm chemical composition of, 461 ff, structure of, 48, 71
 Protozoa, 57 61, 68 69, 79, 83 93, 108, 143 253 ff, immortality of, 79, 80, reproduction of 79 ff
 Providence 40, 243 ff
 Purpose in the world process, chap xi

 Rabl on individuality of chromosomes 88
 Reality, knowledge of, 17, 24, 26, 210, 229
 Recapitulation theory, 125, 163, 287
 Recessive Mendelian 174 ff
 Reduction division of chromosomes 87
 Regeneration organic power of, 50 97
 Regression, Galton's Law of, 151, 162
 Reign of law, 10
 Relations of science and theology, 2 ff, constitutive of science, 13, of organism to environment, 80, 81 100
 Reproduction, characteristic of life, 51 81 ff
 Respiration on mountains 50, characteristic of life, 72, 74
 Response, life the science of 66
 Responsibility personal 197 ff
 Resurrection the 304
 Reversibility, of enzymes, 74

332 SPIRITUAL INTERPRETATION OF NATURE

- Rice, W N., 20, 305
 Robinson, E K, on pain, 134
Roe Richard, Heredity of, 158 ff
 Royce, Professor, on Immortality, 318
 Sabbath, institution of the, 233, 234
 Schurman, J G, 119
 Science relation to Religion, 4
 24, abstract character of, 13, 23, basis of, 11, definition of 12, incompleteness of, 12, as a divine revelation, 34, and origins 22
 Scott, W B, on determinate variation 149
 Seeds, life of 45 73
 Segmentation of egg, 93
 Self-adjustment of organism, 49
 Self-consciousness 109, 206
 Semon 172, 258
 Senses, limitations of the, 14 ff, additional, 15, 17
 Sentientcy, 109, 255
 Service, place of, in the world, 140 ff
 Sex determination of, 87
 Sexual selection, 106, 117
 Shaler, N S, 181, 314
 Shaw, Bernard 194
 Shuttleworth G E, 196
 Sight limitations of sense of 14
 Sin, 282 ff, in relation to Evolution, 285
 Smell, sense of, 14 17
 Sociological aspects of Heredity, chap ix
 Somatic cells, 85 166
 Sorley, Prof, 274 276
 Special Creation, doctrine of 236 ff
 Special Providences 249
 Species, characters of 124
 Spencer, H, 63, 104 n, 137, 216, 217 273
 Star-streaming, 213
 State, and race control 192 ff
 Statistical study of Evolution 145
 Stature, inheritance of, 161 ff
 Sterility and species, 123 ff
 Stimulus response of organisms to, 66 ff
 Strasburger, 89
 Struggle for existence, 126, ethical aspects of, 129 ff
 Suarez and Special Creation, 238
 Suffering, place of, in the world, 140 ff
 Suicide as a sociological phenomenon, 189 ff, relation to insanity, 190
 Summation of stimuli, 256
 Supernatural, relation to the natural, 119, 248
 Swedenborg 104
 Synopsis, 87, 155
 Tactism, nature of, 66, 254
 Teleology, 22 91
 Temper, scientific, in religion, 37, religious, in science, 43
 Tennant, Dr F R, 285
 Tennyson, Lord, 130, 214
 Theology and Science, 4
 Thomson, J A, 104 n, 116, 123 n, 137, 166
 Thorndike, E L, 261, 262, 263
 Time, 226
 Tower, W L, 202
 Transcendence divine, 247
 Trial and error 253, 254, 259, 261
 Tropism, nature of, 67, 253
 Tyler, J M, 210, 212
 Ultimate units of life, 60
 Unicellular forms of life *See* Protozoa
 Uniformity of Nature, 25, 113 ff, 295 300
 Unity of Knowledge, 2, 3, of Nature, 4 219 300, of the organism, 65 ff, 75
 Variation 92, 117, 119, in segmentation, 93, in relation to Natural Selection, 119, chap vii, due to the environment, 156
 Virchow 89
 Vitamines, 74 n
Volvox globator, 57 85*
 Vries, de, 97, 149, 151 ff
 Waggett, P N 6 n
 Walker C E, 89
 Wall of cell, 64, 74

- | | |
|---|--|
| Wallace, A. R., 125, 152, 251 | Wilson, E. B., 65, 83 n., 96, 100, 102 |
| Waller, A. D., 45, 46 | Wonder, the sense of, 43, 303 |
| Ward, J., 25, 172 n | Wood, Rev. T., 132, 133 |
| Ward, Wilfrid, 37 | Woodruff, L. L., 77 n., 79, 91, 92, 178 |
| Weismann, 63, 85, 128, 202, on
immortality of Protozoa 79,
theory of heredity, 97 166 ff,
194, 197 | Woodward Dr. Smith, 224 |
| Wesley John, 340 ff | World-Ground, the, 31, 219, 226, 247 |
| White, A. D., 31 n | World-religions, place and value
of, 33, 34 |
| Will, the divine, 112, 227, 247 | |